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Engineering News-Record

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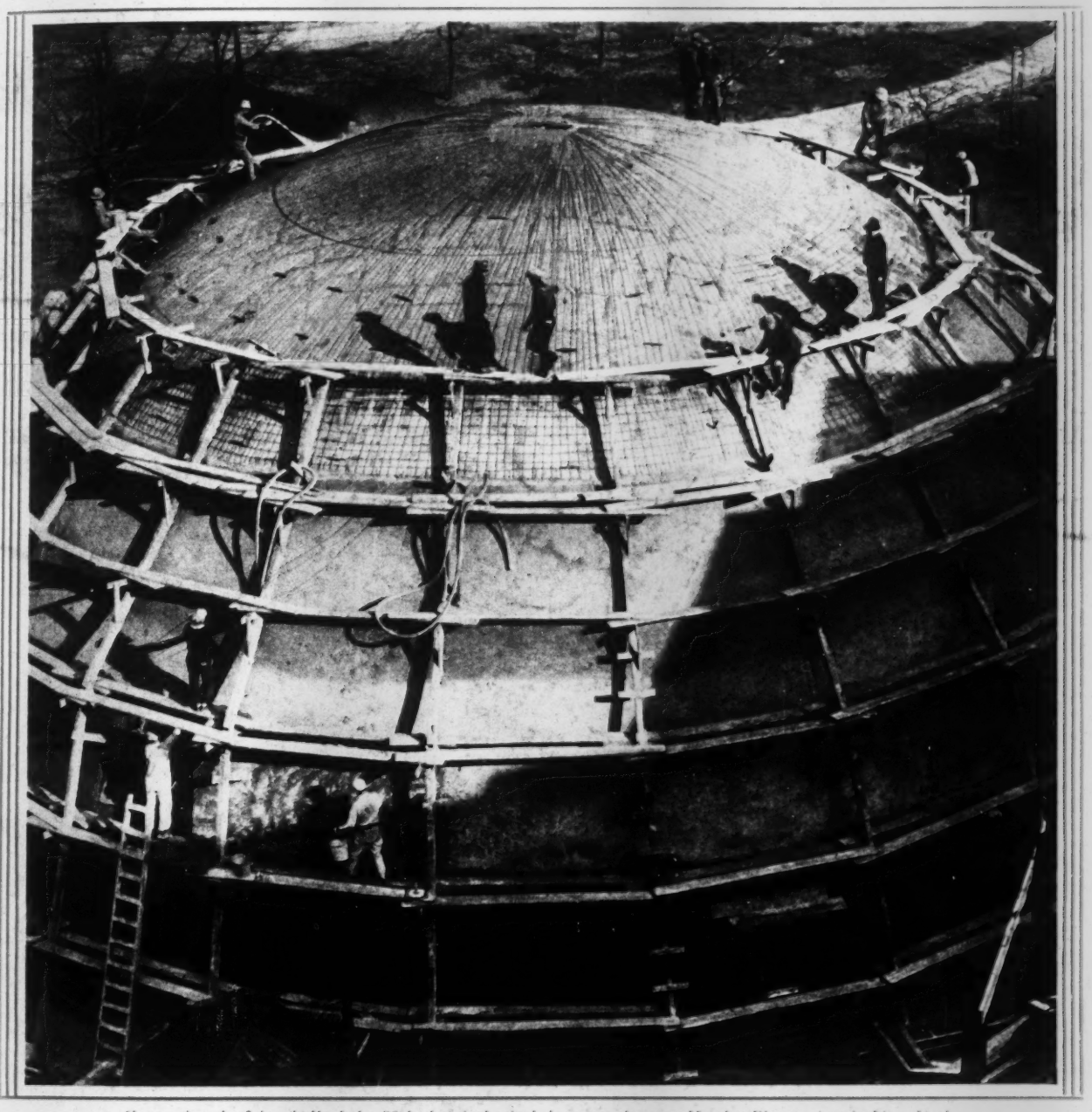

Concreting the 3-in. shell of the 80-ft. hemispherical dome on the new Hayden Planetarium in New York

Thin Concrete Shell Dome for New York Planetarium

Planning Sewerage for a 1970 City

An Appalachian Parkway from Vermont to Georgia

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"This Business of Relief"

LAST week this page spoke for an early revision of the work-relief requirement that 90 per cent of the labor to be used on public works projects should be drawn from the relief rolls. The point was made that such a policy is impractical in that it prevents the employment of those needed for the competent conduct of construction projects unless they should happen to be on the relief rolls at the time they are needed. But another and more far-reaching reason demands that this regulation be overhauled.

Sooner or later someone must lay down some truetalk concerning "this business of relief" as the President has put it; it may as well come right here and now from this writer.

No humane person can fail to sympathize with those who are destitute or dependent through no fault of their own; somehow we must extend to these unfortunates some measure of relief, either as donations or, preferably, through some form of emergency employment. Whether this be done under private auspices or by local or national government is, for the moment, beside the point. The fact is that, for the time being, the federal government has assumed the brunt of the responsibility.

BUT with all due respect for social obligations, by what process of reasoning—philanthropic or otherwise—should we require that in order to find normal employment on a normal public construction project, a competent unemployed workman must first go on a relief roll? Many a good man, long out of work, has hung on by the grace of God and his own self-respect until such time as he could get himself a job. He has battled valiantly to keep his name off those relief rolls; if there had not been many such, the relief rolls of today would be vastly longer than they are. Some of these men and their families constitute the most tragic casualties of the depression.

Now comes an effort to maintain and stimulate the prosecution of a normal public works construction program. It requires his services but he is told that his very efforts at self-help disqualify him. He is told that his civic and social virtue must be its own reward, that he may clothe himself in his pride and feed on his self-respect. He can remain out of a job while precedence is accorded to someone more unfortunate or, as may well be the case, someone less self-reliant and less reluctant to become a public charge.

All this might be excusable if such discrimination were applied only to the work-relief projects. These were created to make jobs; they pay only a subsistence wage that is but a substitute for a dole. On such work no fault can be found if priority be given to those who may satisfy the authorities that theirs is the greater need. But it cannot be excused when it applies to normal public construction projects designed to create useful works and to pay normal wages. On such jobs no valid reason can be offered for passing over the competent unemployed in favor of those whose one qualification may be that they are in sufficient distress to accept relief. Such a procedure is bound to foster the kind of psychology that throws men on the town and to penalize those who manage to keep their names off the relief rolls.

LET us not forget that recovery will be achieved and economic health restored to the nation only when this nightmare of public relief has finally been banished. Today it is becoming more and more obvious that in this development we are at a critical stage. Whatever humanity and social welfare may have dictated heretofore and however urgent may have been the obligations of the community to the individual, the time has come for us to work for greater emphasis on the inevitable obligations of the individual to his community.

It is time to talk less about the individual's right to a living and to dwell more on his right to earn a living, to exalt the virtues that keep men self-reliant rather than the frailties that may excuse their becoming dependents.

In the administration of the public works and work-relief programs, the federal, state and municipal governments have an opportunity to throw their weight to one side or the other. Through the indiscriminate requirement that 90 per cent of all labor be drawn from the relief rolls they very definitely throw that weight in favor of dependence as against self-reliance, in favor of continued relief as against recovery and in favor of passive faith in public support as against the productive qualities of individual competence and effort.

In short, right here is a good place to make a start on the vital process of weeding the relief psychology out of the American soil before it is too late.

Willard Chevalier

ENGINEERING NEWS-RECORD

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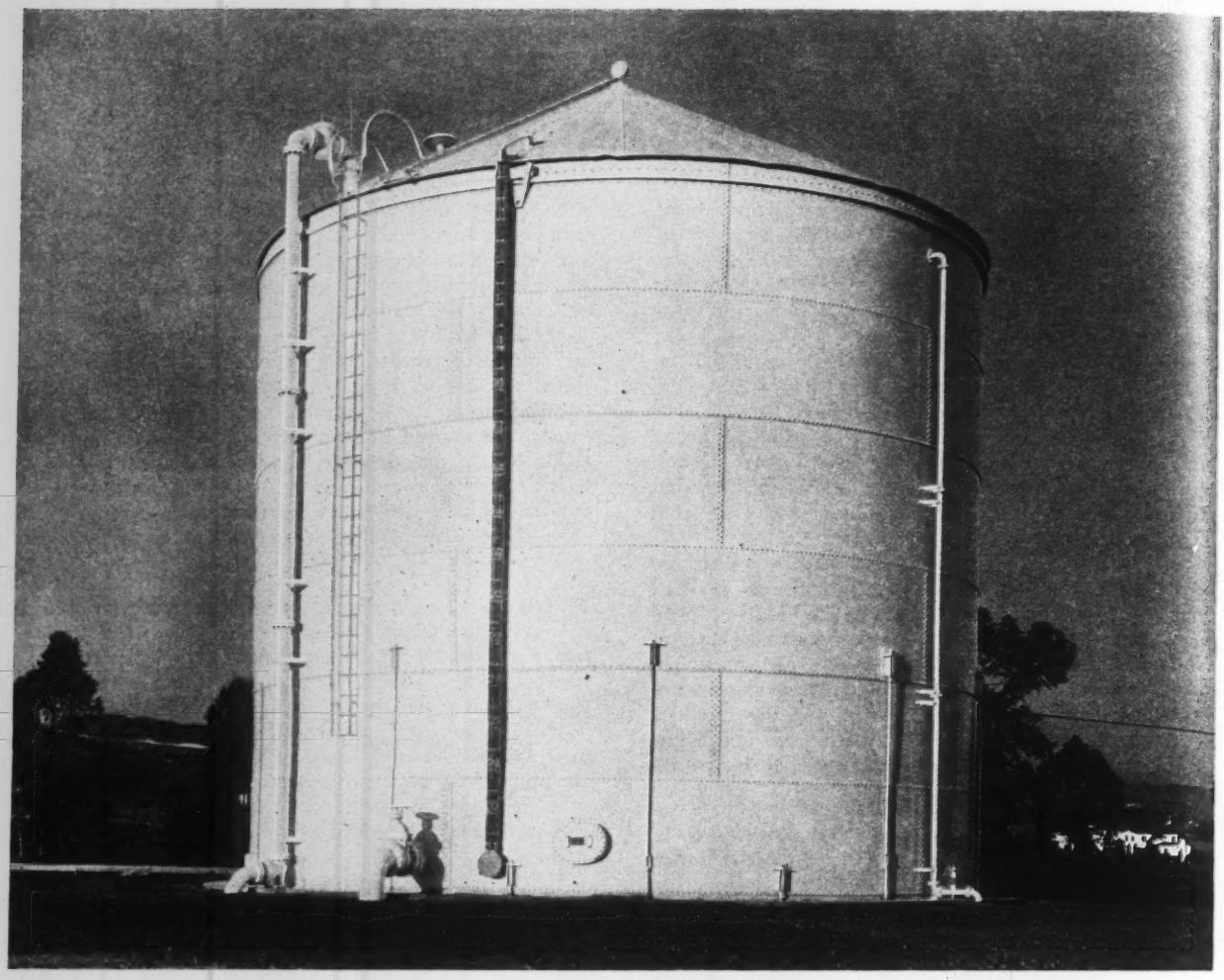

GRAVITY WATER PRESSURE

Gravity water pressure may be provided in several ways. One is to build an elevated tank. Another is to locate a flat-bottom tank on a natural elevation, where such elevation is available.

The waterworks system at the U. S. Veterans hospital near Los Angeles, Calif., utilizes this latter method. The 300,000-gal. storage tank illustrated above is located on a natural elevation which is approximately 150 ft. above the hospital grounds.

The storage tank is filled from the Los Angeles aqueduct system which passes nearby. The water flows from the tank into the distribution system by gravity. No pumps are required.

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In the News:

TVA CAN GO AHEAD with its plans to sell electric power, and Alabama cities that were enjoined from spending PWA money to build distribution systems are free to proceed. So ruled the Circuit Court of Appeals of the fifth federal district at New Orleans in reversing the famous decision of Judge W. I. Grubb of the Northern Alabama Federal District Court.

ARMY ENGINEERS have requested an allotment of $200,000 from WPA funds, to be used in developing a flood-control plan for the New York-Pennsylvania region damaged by floods two weeks ago.

WPA's WHITE-COLLAR PROGRAM for New York City totals over $20,000,000 and includes a number of engineering surveys covering such items as a vehicular tunnel from the Battery to Hamilton Ave., Brooklyn; slum areas and conditions; population and property along a projected Second Ave. subway route; bridge traffic; subsurface rock conditions; triangulation networks; and wasted water.

In This Issue:

FROM GERMANY, the United States is gradually adopting the planetarium in which astronomy is taught by projecting constellations on an artificial sky. Chicago, Los Angeles and now New York have available these interesting and highly educational institutions. New York's new planetarium also uses the type of "sky" used in Germany, a concrete dome of thin-shell type in which by proper reinforcement the pressure lines are fixed beyond shifting and thrust at the springing line is eliminated. The New York hemispherical dome, described in this issue, is 80 ft. in diameter, and the concrete shell is only 3 in. thick. It was built on an ingenious self-supporting centering.

A MOUNTAIN PARKWAY extending from Vermont to Georgia through the Appalachians is under consideration. In Virginia and North Carolina, sections are already under construction, linking the Shenandoah and the Great Smoky Mountains national parks. Both the general plan and the current construction are covered in eight pages of text and illustration.

VIERENDEEL TRUSSES, characterized by an absence of a diagonal web system, are rare in American structural practice, but in Belgium, the country of their origin, several dozen bridges of this type have been constructed. An article reviews the developments of the past two years, during which 25 of them either wholly or partly welded have been built. Earlier ones were of concrete or of riveted steel.

PLANNING A SEWERAGE SYSTEM that will be adequate in 1970 for a population of 170,000 was the task undertaken several years ago by the small industrial city of Cedar Rapids, Iowa. The basis of the planning and the construction of the concrete-pipe interceptors furnish subjects for an instructive article.

A REVIEW OF DUST-STORM DAMAGE to highways in Kansas and Colorado reveals that it was not extensive and that the principal difficulty centered in maintaining the trucks and cars of the highway department that had to operate in the dust.

KNOWLEDGE of breakwater foundation design in locations subject to wave scour is fortified by experience with the failure of a finely built structure at Algiers in Africa. The rubble-mound bases proved so inadequate that at Dunkirk (France) 40- and 50-ton blocks were placed over the riprap. The Algiers and Dunkirk breakwaters and one at Haifa, Palestine, of graded stone are described.

Next Week

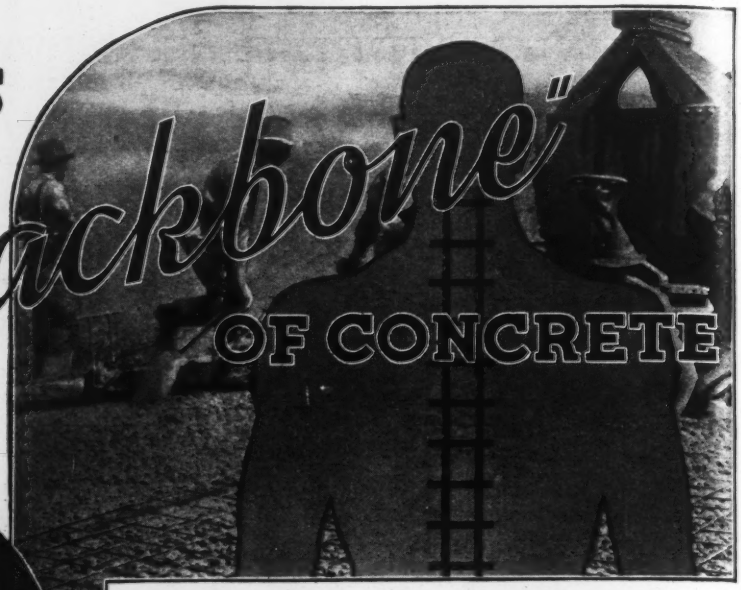
The Story of Grand Coulee Dam—in Nine Articles

¶ "Bigger than Boulder" accurately describes the great Grand Coulee Dam under construction on the upper Columbia River in Washington, to generate power with which to pump water of its own storage 300 ft. higher into an irrigation reservoir formed in the old river bed known as the Grand Coulee. The present low dam will contain 3,500,000 cu. yd. of concrete as against Boulder's 3,400,000, and the ultimate Grand Coulee Dam will require an almost unbelievable total of 11,260,000 cu. yd.

¶ As with Boulder Dam, notable construction accomplishments are of almost daily occurrence. A steel sheetpile cofferdam enclosing only one-third of the site contains 60 acres. A belt conveyor over a mile long transports excavated material at the rate of 40 cu. yd. per minute—50,000 yd. in 24 hours. A completely equipped modern city of 3,000 population serves the builders of the great structure.

¶ The nine articles comprising next week's issue portray the job to be done and the operations that now are contributing to another record-breaking construction enterprise.

BACK OF THIS "Backbone" OF CONCRETE



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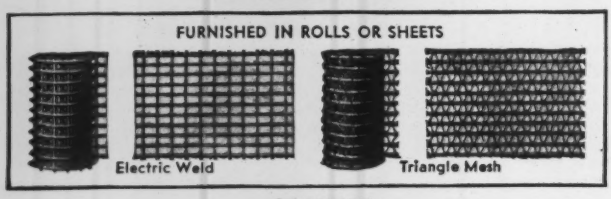

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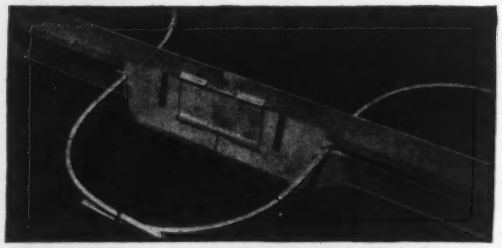

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ENGINEERING NEWS-RECORD

July 25, 1935

FIG. 1—SURMOUNTED by a thin concrete shell dome sheathed in copper, the new Hayden Planetarium in New York City comprises one of the interesting structures of the year.

Thin Concrete Shell Dome for New York Planetarium

Over 80 ft. in diameter and only 3 in. thick, the dome of the Hayden Planetarium exemplifies a new structural form for this country—Building is a two-story steel frame octagonal in plan

By Paul F. Pape

Weiskopf & Pickworth, Consulting Engineers, New York City

THE NEW Hayden Planetarium of the American Museum of Natural History in New York City, now nearing completion, was designed to house in its two stories and basement an astronomical museum, exhibit rooms for mechanized models of the solar system, and the planetarium auditorium. The building is particularly interesting by virtue of a thin concrete shell dome 80 ft. in diameter that forms the roof over this auditorium. Adjoining the present American Museum buildings, the new structure has plan dimensions of 122 x 146 ft. and consists of a structural-steel skeleton frame, cinder-concrete floor arches, and curtain walls of brick, which in the upper two stories are solid on all sides except the front. Large central circular auditoriums with adjoining exhibit rooms are provided at each of the floors. In conjunction with them are auxiliary projection rooms, work rooms and offices.

The main planetarium auditorium, located on the second floor, consists of a circular room with an unobstructed area 78 ft. in diameter and a planned seating capacity of about 750 people. The seats will be arranged in concentric circles around the instruments which project artificial heavens onto a 75-ft.-diameter hemispherical screen hung from the concrete dome. To provide favorable acoustics, the inside of the roof dome is lined with a 1½-in. layer of rock cork insulation, a large air space is provided behind the projection screen, and baffle plates of perforated metal are in the space between the base of the dome and the projection screen.

The building was financed by a loan from the Reconstruction Finance Corp. and a cash gift from Charles Hayden of New York.

Foundation difficulties were anticipated, since it was known that an old lake on the site had been filled in many years ago. The true nature and condition of this fill, however, could only be determined by a very extensive set of borings, and the American Museum officials did not feel justified in assuming the necessary expense, owing to the fact that the loan from the RFC was uncertain and could not be obtained until authentic bids were received on the construction of the building.

Having been engaged on a number of buildings in the American Museum group, the engineers had a rough idea of the conditions that might be encountered, the general elevation of the rock and the location of the old lake bottom on the site. A preliminary foundation design, therefore, was made for spread footings, allowing for a low bearing pressure, minimizing unequal settlement, etc. It was thought this would cover

the extreme case, but when the site was opened up the soil proved an unsatisfactory bearing medium and incapable of supporting as much as 1½ tons per sq. ft.

The actual excavation uncovered a fill consisting of large rocks, irregular in shape and varying in size, cinders and other unstable material with frequent fissures and voids. It did not seem practical to consolidate this fill by the introduction of grout, or to excavate to a lower bearing level which in the end might not be able to carry the loads plus the backfill. The decision was to go to rock with piles.

Since driving piles through the rock-fill was impossible, it was found practicable to dig pits and remove the fill under the pile cap areas. The method of shoring and digging the pits hinged upon leaving sufficient ground surface between pits to support and maneuver a piledriver over the site. It was found best to backfill the pits with sand before driving the piles, which consisted of a closed-end heavy-gage steel shell driven with an interior mandrel, and filled with a 1:2:4 stone concrete. The piles were driven to practical refusal because of the delicate nature of the load to be carried. Due to the dip of the rock surface, the pile lengths varied from 12 to 45 ft.

The basement walls were designed as 16-in. retaining walls, to push against the floor slabs at the first and basement floors, except on the driveway side, where reinforced-concrete beams spanning between pile caps were installed to carry 12-in. brick walls in the basement story.

General framing

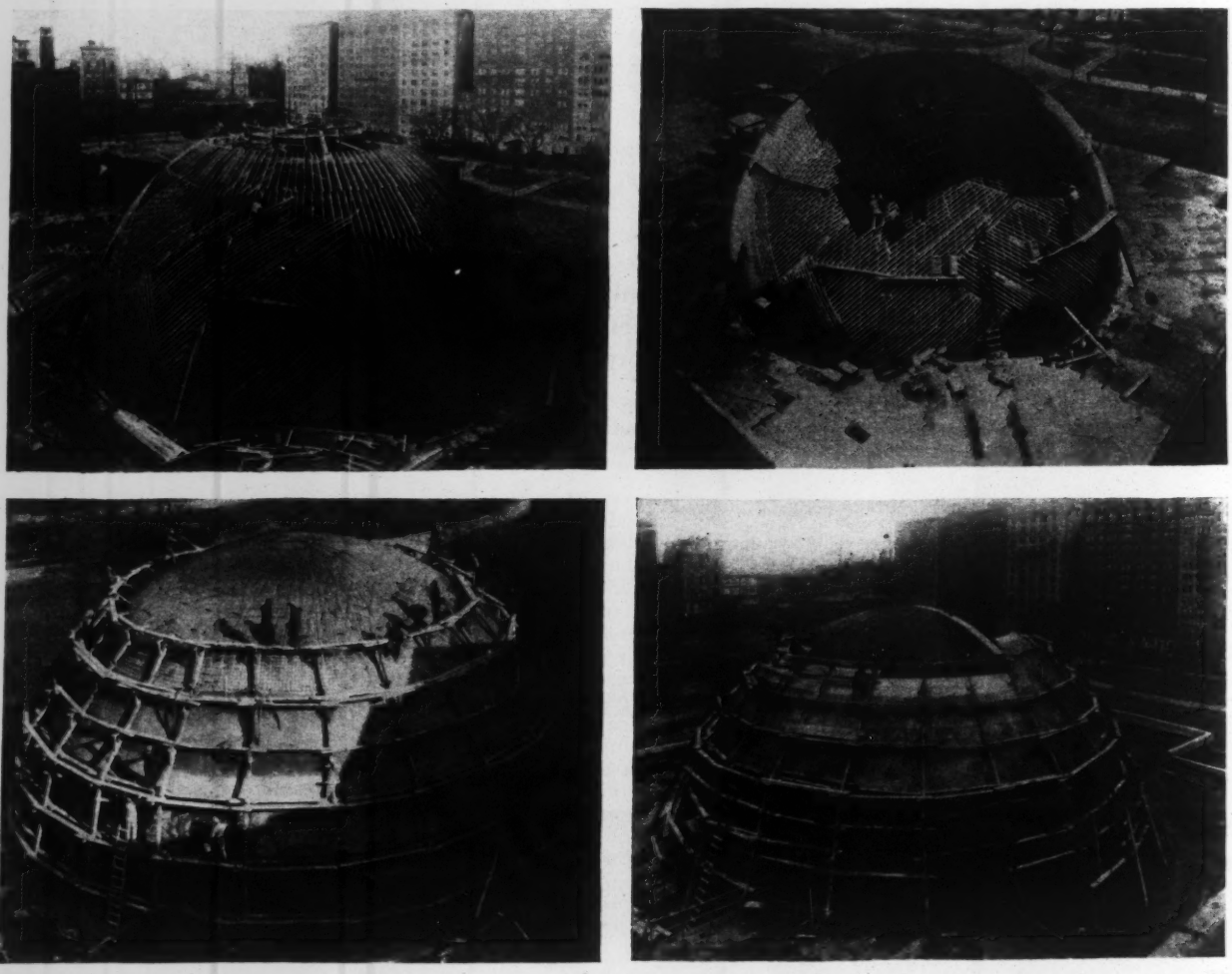
The dome and the circular auditoriums below largely determined the layout of the building framing. An octagonal arrangement of the two interior groups of columns proved best for the architectural requirements. The space between the circular-shaped partition wall of the auditorium and the octagonal-shaped partition wall of the exhibit rooms provided excellent duct space without encroaching into any of the rooms. As far as possible, symmetrical quadrants were used, with the exterior columns arranged to match the interior columns.

The first- and second-floor framing plans are very much alike since the exhibit rooms and the auditoriums have practically the same general arrangement for each floor. One point of difference, however, occurs in meteorite exhibit space on the first floor, where provision was made at various locations for exhibits weighing up to 40 tons each.

The floors were designed for a live load of 100 lb. per sq. ft., and consist of a 4-in. reinforced cinder-concrete slab, a 4-in. cinder fill, and 1 in. of cement finish.

The steel roof framing that supports the dome consists of eight 36-in. girder beams forming an octagon between the columns, supplemented by channels and by cantilever girders that pick up the adjoining ends of each pair of channels. To assure a good bed for the dome and also to tie the supporting frame together in the vicinity of the dome base, a 1:2:4 mix stone concrete was used.

FIG. 2—FOUR STAGES in the construction of a concrete shell dome on the Hayden Planetarium in New York City. Top left: Erecting the self-supporting centering, consisting of rib segments set on rings of pipe and sheathed with plank. Top right: Applying slabs of rock-cork insulation. Bottom left: guniting the 3-in.-thick shell. Bottom right: Finishing the dome with layers of nailcrete and copper sheeting.



The dome is the most striking and interesting feature of the building. Hemispherical in shape and with an inside diameter of 80½ ft., it exemplifies thin concrete shell dome construction on the largest scale yet attempted in this country. The art of dome construction was known to the ancients, but thin domes date only from the introduction of reinforced concrete, which aided first in the development of arched rib domes in which curved thin slabs span between the ribs, and later in the development of the true thin shell dome.

Necessity made the early domes rather thick structures, as evidenced by the dome of St. Peters Cathedral, which is 9 ft. thick for the lower quarter and consists of a double shell in the upper three-quarters. The dead weight in such a case far exceeds the live loads and was therefore the major consideration. Today the shell thickness is reduced to a matter of inches instead of feet, and the dead weight of the shell itself sometimes drops below the live load and superimposed loads.

Shortly after the construction in 1913 of a 213-ft.-diameter arched rib dome over the Market Hall of Breslau, Germany, perfection of a true thin shell dome became possible. Further knowledge of the analysis of shell slabs and structures aided this, and in 1924 the first application of thin shell domes was used on the planetarium at Jena, Germany. Thus it is only recently that this form of construction has come into its own in Europe (*ENR*, April 14, 1932, p. 537) and is now finding its way into America.

The Hayden Planetarium dome, a 3-in. Gunite concrete shell spanning 80 ft., brings out forcibly a realization of what a strong form a hemispherical dome is. By considering the theory of domes, this great strength is readily accounted for. A dome can be considered as an indefinite number of arches, all starting at the springing line and all intersecting at the crown. Each of these arches has a rise of one half the span. One would ordinarily consider an arch of such proportions as a quite efficient load carrier. However, should the pressure line on one of these arches tend to depart from the center of the shell causing a bending stress, the same action under any symmetrical loading would occur in all of them. This would produce a tendency to burst the shell outward or inward around any horizontal circle. In a dome such an action is resisted by a horizontal ring of reinforcement where the bursting pressure is outward, and by compression around the horizontal circle where the pressure is inward. Ring stresses in the dome at right angles to the direct meridional compression are thus produced. The effect of resisting these ring stresses is to maintain the pressure line at the center of the shell at every point, so that there are no bending stresses.

A clear conception of the size and variation of stresses in the Hayden Planetarium dome is shown in Fig. 5. The direct (meridional) stress and the ring stress are plotted for a dead load of 55 lb. per sq. ft. The ring stress is compression near the top of the dome but changes at a latitude of about 39 deg. to tension. At the springing line the pressure line is vertical, showing that there is no horizontal thrust on the supports. This means that the entire horizontal thrusts of the arch elements work against each other and are completely resisted by the tension rings.

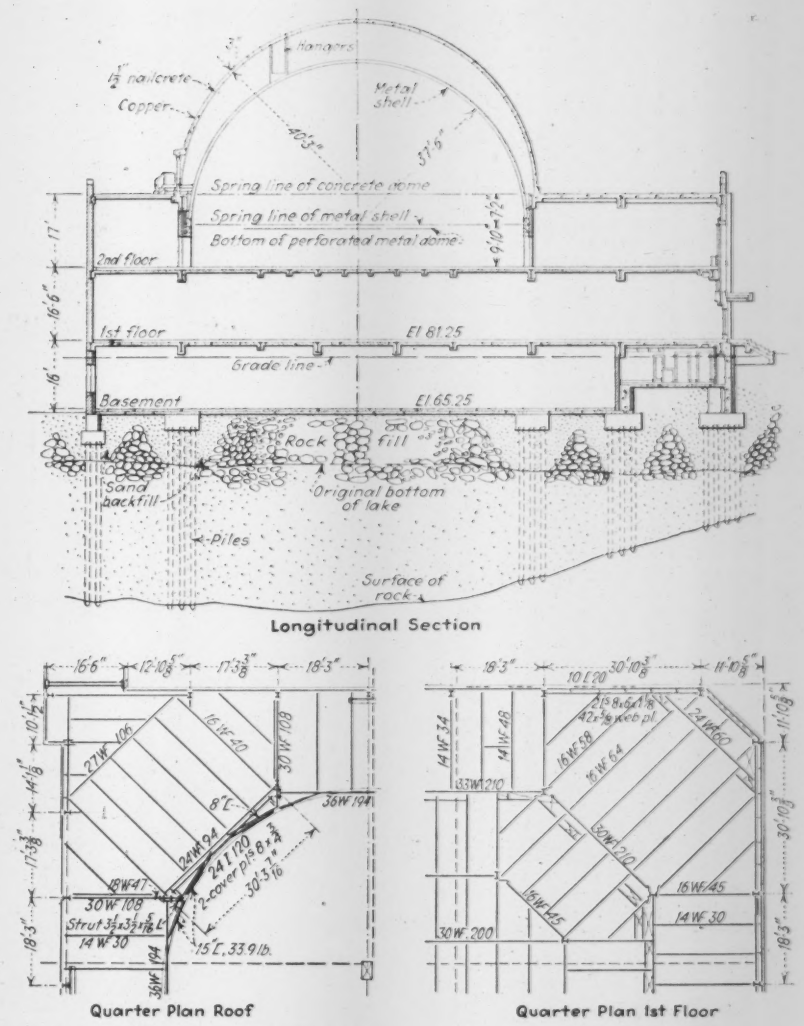


FIG. 3—STRUCTURAL PLANS of Hayden Planetarium building in New York City, showing octagonal arrangement of steel columns and the steel cantilever beams that support the thin concrete shell dome.

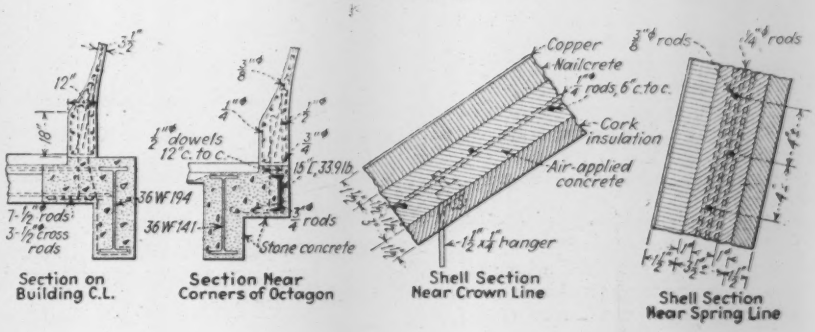


FIG. 4—SECTIONS of the concrete shell dome showing reinforcing, insulation and exterior covering.

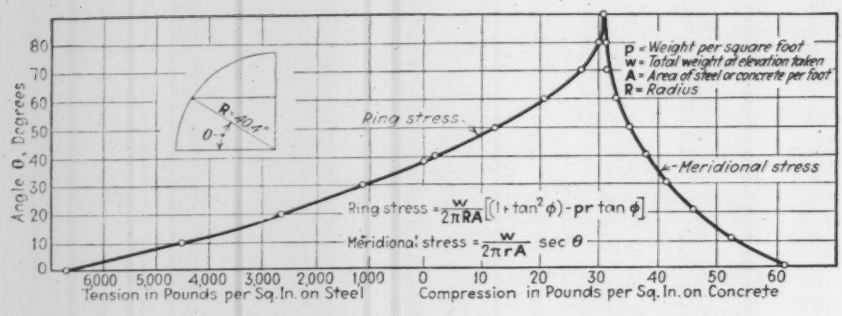

p = Weight per square foot
w = Total weight of elevation taken
A = Area of steel or concrete per foot
R = Radius
Ring stress
Meridional stress
Ring stress = $\frac{w}{2\pi RA}[(1+\tan^2\phi)-pr\tan\phi]$
Meridional stress = $\frac{w}{2\pi rA}\sec\theta$
Angle θ, Degrees
Tension in Pounds per Sq. In. on Steel
Compression in Pounds per Sq. In. on Concrete

FIG. 5—VARIATION of stresses from crown to spring line in thin shell concrete dome of 80-ft. 6-in. diameter.

The action of wind, snow and unequal loading on the planetarium dome was a minor factor in design. The wind action on a body whose height is one half of its base dimension and whose face is curved detracts little from the stability. The wind force was assumed at 15 lb. per sq. ft. on both faces—pressure on the windward side plus suction on the leeward side.

The maximum stresses for concrete and steel are (in lb. per sq. in.):

	Concrete	Steel
Dead load	61.6	6,700
Snow	33.6	3,700
Wind	16.8	3,700
Max. stresses	112.0	14,100

The dome not only serves as a roof but also as a support for the projection screen that is hung over the planetarium auditorium. This screen is made of a thin, finely perforated, stainless-steel plate and is carried by hangers at about 7-ft. centers. The dome shell is protected from the elements by a 1½-in. layer of nailcrete, which in turn is covered by 16-oz. copper sheeting.

The shell thickness is 3 in. over the upper portion but is increased to 3½ in. at a point 9 ft. above the springing line and again to 12 in. at a point of 1½ ft. above the springing line. Theoretically the shell thickness could be made much thinner, but for practical considerations the above was considered advisable. Although band stresses at the springing line are small due to the hemispherical shape, the lower band was thickened, to minimize the effects of unequal deflection or settlement of the supports.

The main portion of the dome was Gunited with a 1:3½ mix in eleven working days, using an ingenious self-supporting centering, described in the following article, to support the dome forms. Construction joints were allowed only in concentric horizontal rings.

The Gunite was reinforced with two sets of rods placed in the center of the shell thickness at 90 deg. to each other with one set parallel to the base. Three layers were used in the upper portion and five layers in the lower. The lower 4 ft., because of its thickness, was of poured concrete, and was placed in one continuous operation.

Personnel

Trowbridge and Livingston, New York City, were the architects, and Weiskopf and Pickworth, New York City, were the consulting engineers. White Construction Co., New York City, was the general contractor, and the Lehigh Structural Steel Co., Allentown, Pa., was the structural-steel fabricator. Roberts & Schaeffer Co., Chicago, Ill., are the agents in this country for the Zeiss-Dywidig system of dome construction used.

Centering for the Planetarium Shell Dome

By R. L. Bertin
Chief Engineer, White Construction Co., Inc. New York, N. Y.

THE AWARD of the general contract for the construction of the Hayden Planetarium carried with it the obligation on the part of the contractor to devise a system of formwork for the construction of the shell dome such that the profiles of the finished structure would not deviate from a true sphere by more than ½ in.

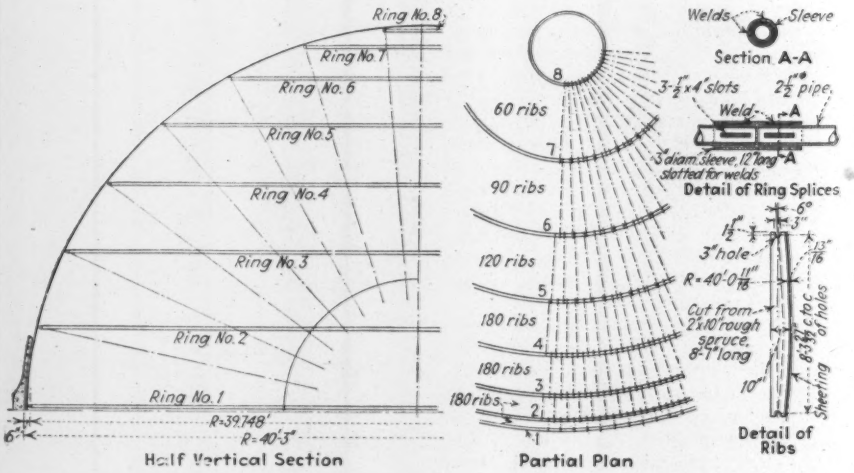
A preliminary study of this problem eliminated from consideration the usual types of shored centering because of the difficulties involved in building such a lofty curved structure to such a degree of precision at a reasonable cost.

The type of formwork much used in Europe for shell structures, best described as "a self-supporting network of V-shaped steel units," could not be used because foreign products were ruled out of consideration, and none of the special machines with which to stamp out the V-shaped units were available in this country.

After due consideration, a prefabricated system of forms was evolved, whose assembly produced a true sphere. This form system consisted of shop-made meridional wood ribs (cut from 2x10-in. rough spruce), vertically inclined and set between and supported by horizontal rings of 2½-in. extra heavy pipe equally spaced 8 ft. 4 in. apart and at proper elevations to fit the curvature of the dome.

Pipe was used for the rings because it permitted an ideal connection between the rings and the meridional ribs and imparted the greatest rigidity to the rings for a given steel section. For each ring, stock lengths of pipe were bent in the shop, loosely assembled and checked for true curvature and radius. The sections were then marked and delivered to the site, where they were reassembled on top of a light scaffold, and the in-

SELF-SUPPORTING CENTERING DETAILS used in constructing thin concrete shell dome for planetarium in New York City.



dividual sections of each ring were joined by a slotted pipe sleeve welded to the pipe through the slots. The lower pipe rings were joined together, welded and set in place ¾ in. below the theoretical elevation. The wood ribs were then inserted between the lower two rings by inclining the ribs at an angle and then forcing them into a vertical position. As work proceeded around the circle, the ring was gradually lifted free of the falsework. The first ring was made to rest on channels intended to carry the permanent catwalk at the spring line between the concrete and the steel dome. As an additional precaution, posts were placed under the rings, to supplement the support provided by the channels.

The pipe sleeves were spaced equally, so that all ribs were alike. One edge of the meridional ribs was cut to the curvature of the dome at the mill, and a 3-in. hole was drilled at each end and slotted, to form a socket to fit over the pipe rings. The meridional ribs were spaced about 16 in. on centers.

In erecting this structure, the only checking necessary was to make sure that each ring, once seated in the top sockets of the meridional ribs below, was horizontal.

The sheathing, consisting of 4x1⅜-in. strips of wood, was laid diagonally across the ribs, and the direction was alternated at intervals, thus providing all necessary bracing against wind loads and eccentric loading caused by the progressive application of the concrete. The sheathing boards were laid about 4-in. apart, the cork insulating boards serving as the backing on which the Gunite was shot.

This type of form proved very economical and removed many of the uncertainties of cost incidental to formwork of an untried nature. The working scaffold and the pipe rings were sublet, and the meridional ribs were bought ready to install. The labor cost of installing the ribs and sheathing and dismantling them was less than that of ordinary floor forms. Checks of the forms, from the center of the dome, made after the forms were completed, during concreting, and after the dome was finished, indicated the structure to be within the specified tolerance.

Engineering in Foreign Countries

Accounts taken from the foreign-language periodicals of important activities in engineering research, design and construction being carried on beyond the United States

TO GIVE the readers of *Engineering News-Record* quick glimpses of engineering activities beyond the United States, these short abstracts of articles and papers published in languages other than English are presented monthly. In these abstracts no attempt is made at a compendium of foreign-language articles, but selection is made from articles that emphasize some procedure or invention in engineering practice that has general interest or usefulness.

Previous groups of these abstracts from foreign periodicals have been published in *Engineering News-Record* of Jan. 31,, Feb. 21, March 28, April 25, May 30 and July 4, 1935.

The spherical pitometer

The spherical pitometer invented by Prof. Van der Hegge Zijnen several years ago, for the simultaneous determination of the static pressure, the magnitude and the direction of the velocity of fluids, consists principally of a metallic sphere, nearly ½ in. in diameter, having five apertures connected in a one-to-one correspondence with five mercury gages. The apertures are arranged in the form of a rectangular cross occupying a portion of one hemisphere. The sphere is attached to a shaft carrying a circular plate graduated in degrees of arc.

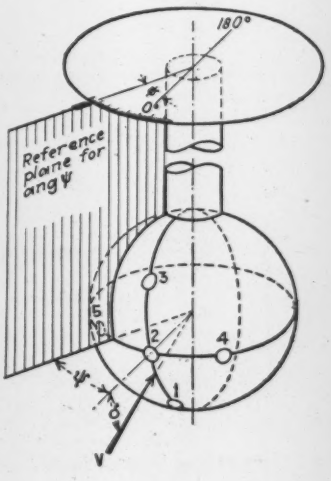
The special province of this instrument is the gaging of flow in pipe lines, including suction and delivery tubes of centrifugal pumps. It operates correctly under all conditions of steady flow—the streamlines need not be parallel, and their velocity may vary greatly. It will also work when placed in pipe bends, in tapering sections or near a butterfly valve. Its precision is claimed to be at least as high as that of a current meter with the advantage that it can be introduced into the pipe lines through a ¼-in. hole, while a current meter requires a hole at least 4 in. in diameter.

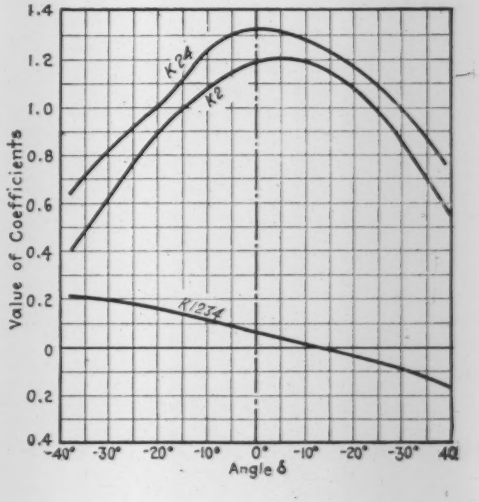
The theory of the spherical pitometer, or "pitot-sphere" has been outlined by its inventor, in the *Proceedings* of the Royal Academy of Science, Amsterdam, Volume 32, No. 5, 1929. Large-scale tests and its commercial use by the Swiss firm, Sulzer Brothers, Ltd., in gaging the discharge from a large drainage pumping plant in lower Egypt, are reported by J. Lalive in *Schweizerische Bauzeitung*, Feb. 23, 1935.

The tests made in the Winterthur laboratory involved the measurement of velocities and the plotting of velocity contours in a 24-in. pipe at a section about 12 in. upstream of the suction elbow of a low-lift centrifugal pump. The average velocity was about 10 ft. per second. The pitot-sphere measurements, checked with a calibrated weir, showed only 1 per cent divergence.

The measurement of the discharge from the 59-in. delivery pipe of the Egyptian drainage pumping plant (amounting to about 56,000 gal. per min.) was first attempted with current meters both at the entrance to the suction channel and in the open inlet canal. Both sets of measurements proved unreliable. Measurements subsequently made with a pitot-sphere, set in the discharge pipe at a section not quite

SPHERICAL PITOMETER AND CHART used in computing results of readings.





16 in. upstream of a butterfly valve, were acknowledged to be entirely satisfactory.

The procedure is as follows: pitot-sphere readings are taken at proper intervals, up to 5 in. apart, along two diameters perpendicular to each other. At each measurement point the pitot-sphere is set with its apertures facing the current, and its shaft is turned until the pressures at apertures 4 and 5 become equal, whereupon the angle ψ—between the meridian plane 1-2-3 and an arbitrary reference plane,—is recorded, and the readings of the five mercury gages are taken. Next, compute coefficient K_{1234} by the formula

$$K_{1234} = \frac{h_1 - h_3}{h_2 - h_4}$$

where h_1, h_2, h_3 and h_4 represent the readings for apertures 1, 2, 3, 4. With the value of K_{1234}, thus computed, enter the calibration chart and read angle δ—between equatorial plane 4-2-5 and direction of flow. Reentering the calibration chart with value of δ, obtain coefficient K_{24} and find velocity of flow V by:

$$V = \sqrt{\frac{2g\,(h_2 - h_4)}{WK_{24}}}$$

where g is the gravity coefficient and W is the unit weight of the liquid. The static pressure p is determined by:

$$p = h_2 - \frac{K_2\,W\,V^2}{2g}$$

The value of the coefficient K_2 is obtained from the calibration curve.

Circular tower hotels

Two hotel buildings of unusual design have recently been completed at Sestrieres, a winter sports resort in the Italian Alps, at an elevation of about 6,700 ft. above sea level. They are described by A. P. Ducret in *L'Entreprise Francaise* of May 25, 1934.

The smaller of the two, known as the "Tour de Sestrieres," is a circular thirteen-story tower, 125 ft. high, 59 to 62 ft. in diameter, built entirely of reinforced concrete. Its cylindrical shape was found particularly economical on account of saving in heating costs. It was found that an equivalent building of orthodox prismatic shape would have a perimeter greater by 30 per cent, with an extra 6,500 sq.ft. of exterior walls.

The ground floor is a large dining room, and the top floor is a club room. The 160 guest rooms or "cabins" are ranged along an interior spiral ramp 4 ft. wide, rising at a grade of 8.6 per cent. Thus, the stories of the tower are not flat, though the floor of each room is flat and the difference in the elevation of any two adjacent room floors, amounting to about 5 in., is compensated for at the dividing wall. Each loop of the spiral ramp gives admission to sixteen trapezoidal "cabins," 12.3 ft. long, about 7.5 ft. high, varying in width from 5.9 to 10.2 ft., also to three toilets and to an elevator shaft.

Each room has one rectangular double-pane window that turns on horizontal pivots not unlike a ship's porthole shutter. Special devices allow the windows to be hermetically shut against the storms common at this high altitude. Artificial ventilation is provided through the central shaft of the tower, which has a diameter of 26.25 ft.

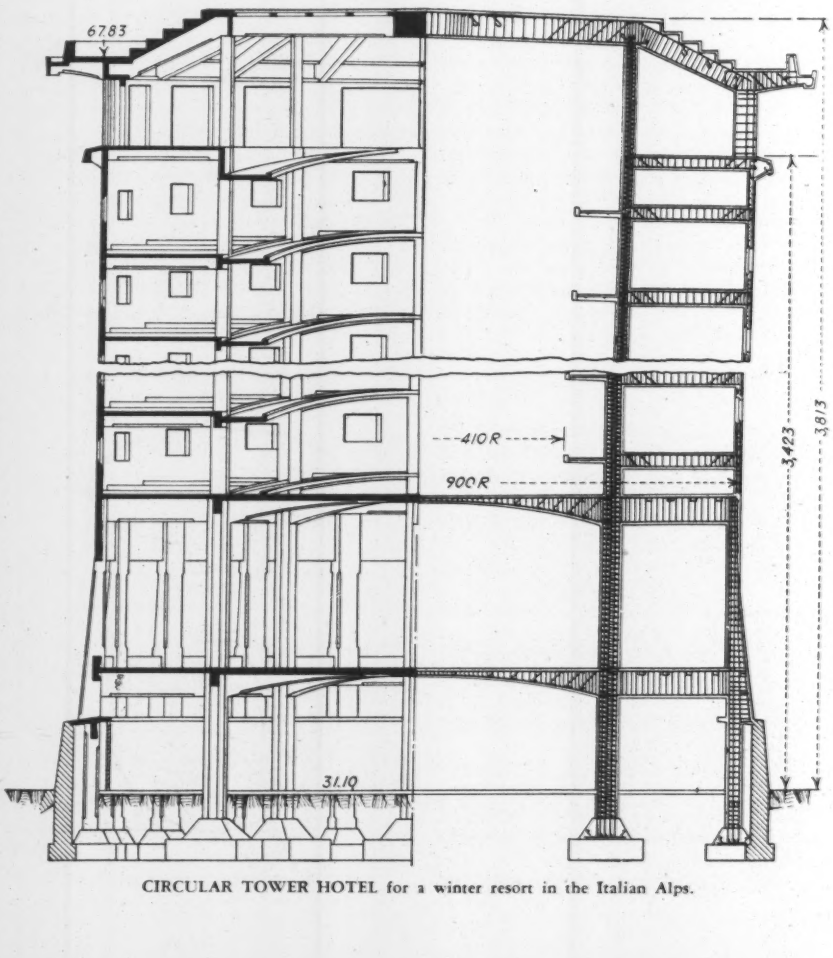
The tower is founded on schist and graphite rock of rather low bearing power, which is allowed to carry about 3 tons per sq.ft. The reinforced-concrete framework of the tower consists principally of an exterior series of eighteen columns and an interior one of nine columns, which are all tied together with straight beams of rectangular section forming two concentric polygons at each loop of the spiral ramp. These beams are not level but follow the inclination of the interior ramp. Level radial beams, $4\frac{3}{4}$ in. wide, connect the two polygons and complete the perimeters of the supporting frames for the fixed floor slabs. The exterior cylindrical wall has a uniform thickness of about 6 in. All partitions and interior walls are built of hollow brick of various types. The roof slab is heavily reinforced on account of the extraordinary snowfall characteristic of the region. The total cost of this tower was 1,000,000 Italian lire (about $132,000), or 10,000 lire ($825) per room.

The other tower hotel at Sestrieres, known as "Duke of Aosta," has been built largely along the same lines but is of greater dimensions. It is 154 ft. high (sixteen stories), and 82 ft. in diameter. Its exterior shell consists of two walls, $4\frac{3}{4}$ in. thick, enclosing a heat-insulating air space. Special soundproofing was provided, to eliminate noise from the ventilating and heating plants.

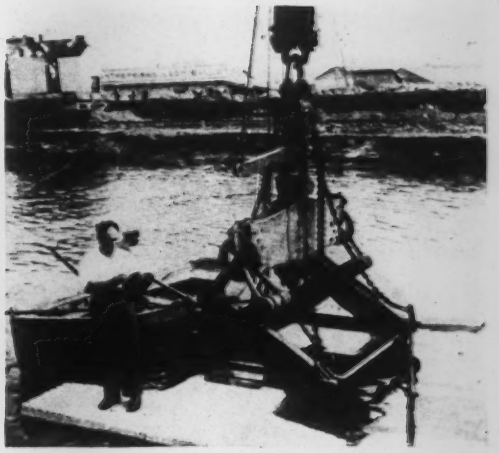
"Compound" seawalls in French Africa

A new stystem of seawall construction is advocated by its designer, L. Ravier, in *Travaux*, November, 1934. The term "compound," borrowed from steam-engine practice, is applied to the construction to indicate that rockfill pressure on the back of the wall acts discontinuously at two levels, as shown by the accompanying cross-section.

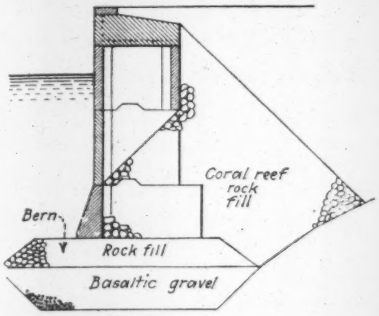
Such seawalls as were actually constructed during the past year at Djibouti, in French Somaliland, and at Bône, in Algeria, consist of three to five tiers of



CIRCULAR TOWER HOTEL for a winter resort in the Italian Alps.



PRECAST-BLOCK hollow seawall under construction at Bône, Algeria.



SECTION of precast-block hollow seawall 37 ft. high constructed at Djibouti in French Somaliland in Africa.

huge precast plain concrete blocks, up to about 12 ft. in height, having a T-shaped cross-section. The blocks of the uppermost tier are of I-shaped cross-section and are capped with a thick heavily reinforced concrete slab. The rockfill back of the wall is in contact with the landward flanges of the I-shaped blocks of the uppermost tier and also with the flanges of the T-shaped blocks of the one or two lower tiers. Between these two levels the rockfill is sloped at its natural angle of repose thus exercising no thrust on the intermediate tiers.

The author gives no mathematical analysis of the stability of this hollow type of seawall but reports results of comparative laboratory model tests and of field observations which show that displacements of such seawalls, when heavily or fully loaded, amount to only two-thirds or even one-third of the displacements suffered by an equivalent solid-type wall of good orthodox design. The tests have also shown that stability requires that the seaward berm of the underlying foundation rockfill should extend away from the face of the wall for a distance equal to at least one-fifth of the height of the seawall.

The economy of the compound hollow type of construction can be appraised from the following: the appropriation originally made for a 460-ft. solid seawall at Djibouti sufficed for a compound hollow seawall 656 ft. long, which is also to be credited with greater stability.

The Djibouti seawall consists of three tiers of concrete blocks which, including the top slab, total 37 ft. in height. The seawall at Bône, Algeria, consists of five tiers and two top slabs totaling about 41 ft. in height. At Djibouti the concrete blocks were cast in the port on an old pier. At Bône a special casting yard had to be provided farther inland. The Djibouti blocks are keyed together; at Bône, in the light of later tests, this practice was abandoned as unnecessary.

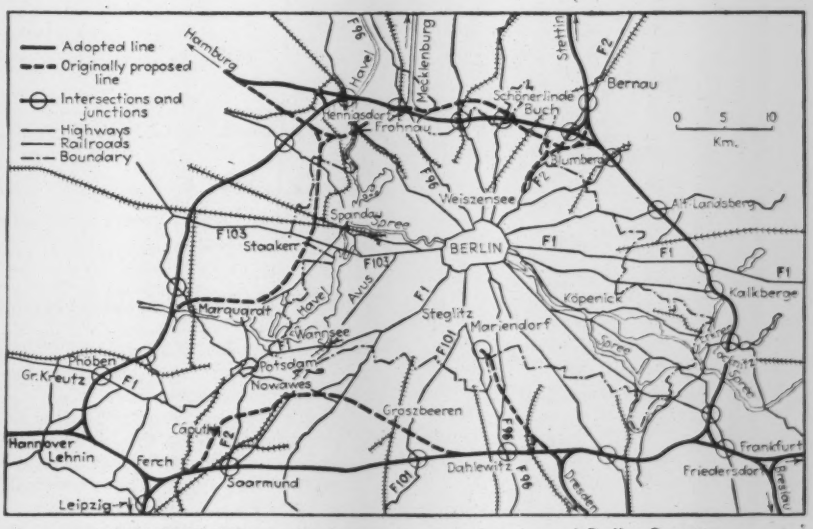
Belt highway for Berlin

Construction of a belt highway 112 miles long around Greater Berlin has been begun this year. According to E. Gerlach, writing in *Zeitschrift des Vereines Deutscher Ingenieure*, Feb. 16, 1935, this highway is being constructed not only for the convenience of the 4,000,000 inhabitants of the capital of Germany but also to enable foreign long-distance traffic between the many cities, around Berlin, within a radius of 150 miles, to bypass the congested metropolitan area with a minimum loss of time. Incidentally, this will relieve present traffic conditions in Berlin.

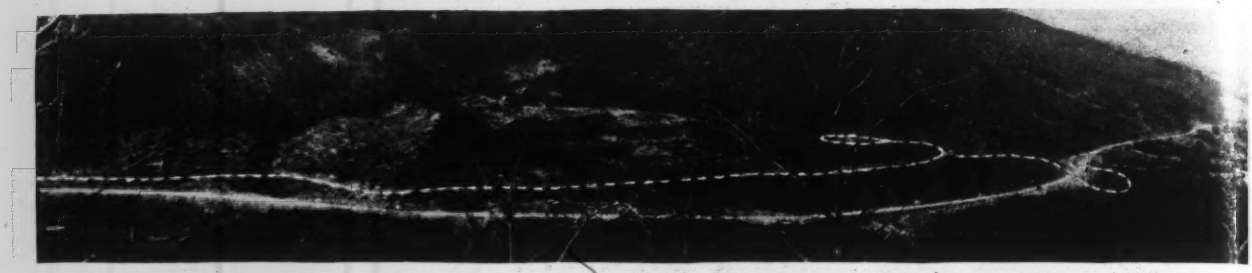
The originally proposed highway plan is shown on the map as a broken line, and the plan finally adopted is indicated by a solid line. It will be noted that the plan gives Berlin a rather wide berth, partly out of necessity on account of Potsdam and similar suburban developments but mainly to allow the expanding metropolis to broaden out without undue restraint.

Radial traffic arteries, originally proposed, were abandoned as inviting congestion and it was decided to distribute radial traffic more uniformly along the entire perimeter of the belt highway by diverting it onto existing highways leading to and from the center of the city. The belt highway calls for the construction of 18 railroad crossings and some 200 bridges and viaducts, two of which will be 3,300 and 5,000 ft. long.

Construction has been started simultaneously at several points, in 18-mile segments.



BELT HIGHWAY 112 miles long under construction around Berlin, Germany.



STRAIGHTENING OUT a crooked line in relocating old road in Great Smoky Mountains National Park.

A Thousand-Mile Mountain Parkway From Vermont to Georgia

AN APPALACHIAN PARKWAY extending over 1,000 miles from the Canadian border to the plains of Georgia is contemplated in the thinking of high administration officials at Washington. At present about half of this road is actually under survey, and construction has been begun in some of the park areas. This part includes the Skyline Drive in Shenandoah National Park, Virginia, and its extension south and west along the Blue Ridge to and into the Great Smoky Mountains on the boundary line between North Carolina and Tennessee. From Shenandoah Park north the road is only a thought, tentatively marked by an ink line on the map of the Appalachians; the consent and cooperation of many states have to be negotiated before the north road can be considered a probability. The south road is an accomplishment that is as positive as anything that the future can promise. Together the two roads sublimate recreational highway planning.

The Appalachian road north from Shenandoah Park is said to have been the suggestion of President Roosevelt. The southern extension, however, was the development of the natural thought of linking together the 140 miles of mountain-crest road being progressively constructed in the Shenandoah and Great Smoky parks. The project appealed to and was actively espoused by Secretary of the Interior Ickes in whose department the National Park Service operates. Under Secretary Ickes, the Public Works Administration set aside $6,000,000 for inaugurating the work, and an agreement was made with the states concerned whereby (1) the federal government was to select the route and assume all construction costs and, (2) the states were to provide the right-of-way and deed it to the federal government and were to place their surveyors at the service of the government in locating the preliminary line.

In the preliminary routing, rivalry arose between North Carolina and Tennessee, and two routes were presented for the consideration of the federal officials. After various hearings and representations the North Carolina route was adopted by Secretary Ickes. This is shown by the heavy solid line on the map opposite, on which there is indicated by a light line the general route of the proposed Tennessee road. The choice of the adopted route was based on the fact that Tennessee already had one entrance to the Great Smokies Park, and that the North Carolina route was equal scenically and would be higher and cooler.

Highway and road are merely terms of convenient designation and not of true definition in speaking of the Appalachian project. It is a travel route solely for recreation. Commercial travel will be banned, and probably such traffic will find nothing to attract it, as the road will shun cities and industrial centers to seek wild places in mountain and valley from which commerce is removed as far as possible. Nor in line, grade or surface will the road be suitable for commercial travel. It is a parkway, not seeking the most direct route but rather the most attractive and scenically varied route, and also not a parkway in the metropolitan-parkway meaning of wide paved multiple travel lanes. The parkway characteristics will exist in wide right-of-way and adjacent land easements, to preserve natural beauty and develop scenic attraction and to give areas for rest and refreshment and for essential car service, camping and hotel accommodations.

Obviously, conditions quite different from those of the ordinary highway must control the engineering of a road of the character indicated. Also, as has been the case with most roadbuilding of the depression years, relief-works elements have entered to modify customary construction practices. To present some idea of what these influences were and how they are affecting actual work, editorial visits were made to construction operations in the Shenandoah and Great Smoky Mountains national parks, and contribution was sought from the federal authorities of an account of the interpark highway routing and planning. These accounts follow under separate titles. The accompanying small map indicates the geographic range of the Appalachian Parkway. The routing, so far, has no official standing.

Shenandoah-Great Smokies Interparkway

As described by Stanley W. Abbott, landscape architect, National Park Service, in collaboration with William M. Austin, highway engineer, U. S. Bureau of Public Roads

THE PARKWAY along the part of the Appalachian Mountain range in Virginia and North Carolina is 500 miles long, traversing two states, and is one of the longest roads to be planned as a single unit in American roadbuilding history. It will be the highest road in the East, averaging 2,500 ft. above sea level. Other reasons, however, make the project of most interest to the planning professions.

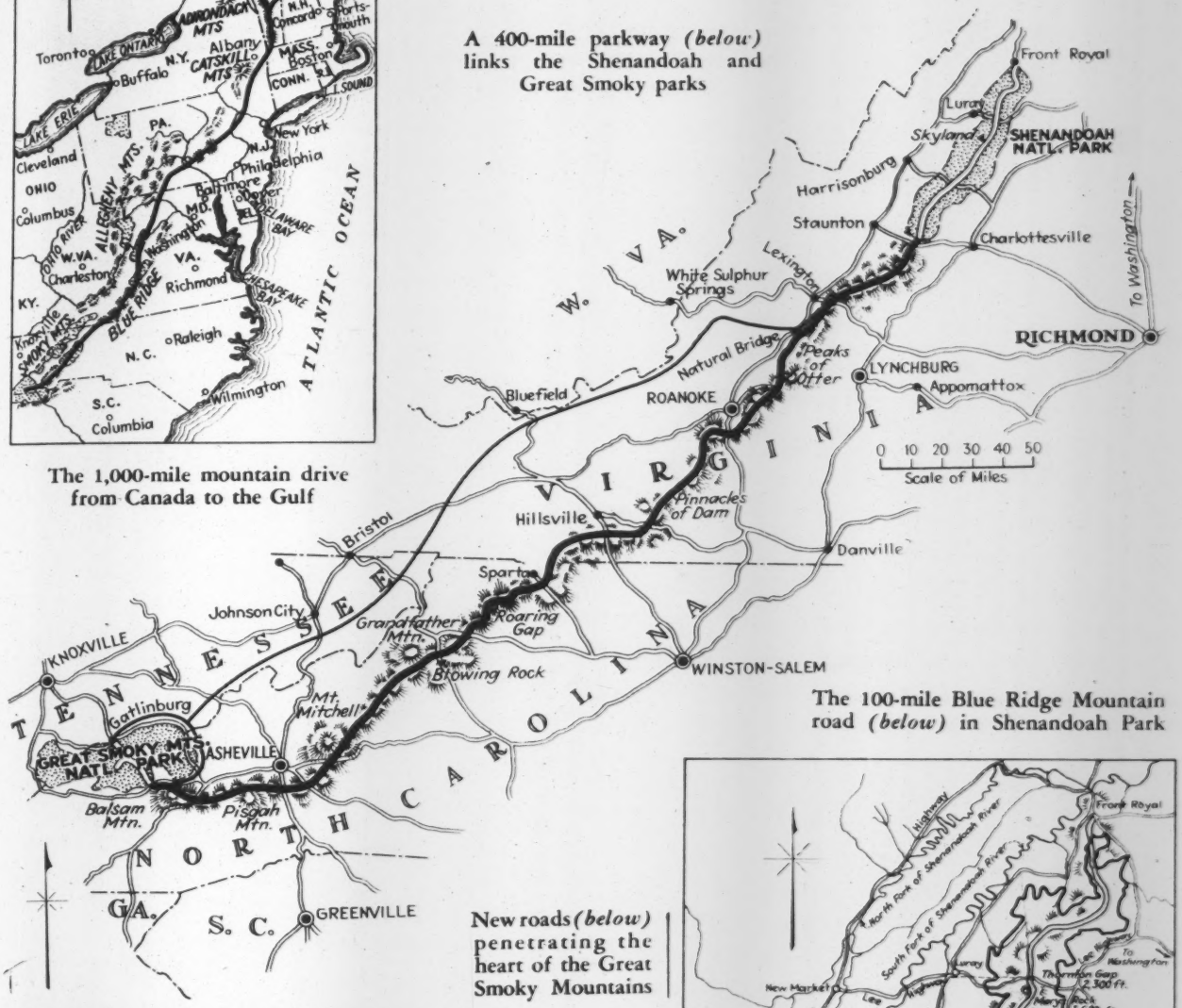
General Planning Features—The project, estimated to cost finally in the twenty millions, will connect the Shenandoah and the Great Smoky Mountains national parks by a scenic drive through the mountains. The two parks are being developed with roads and recreation features, and temporarily at least will constitute the terminii of the new drive.

Since the mountains are flanked by state highways, it is considered prac-

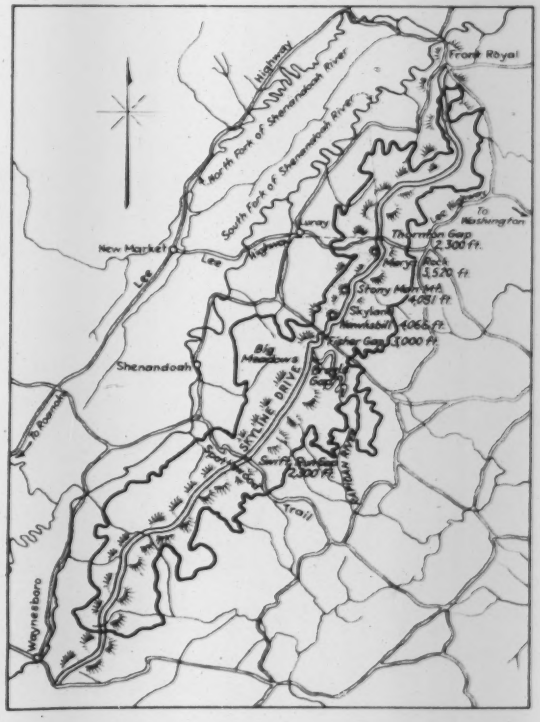
Appalachian Parkway and National Park Roads

The 1,000-mile mountain drive from Canada to the Gulf

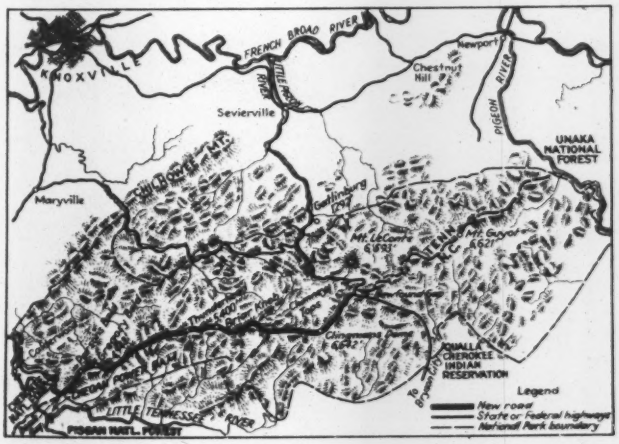
A 400-mile parkway *(below)* links the Shenandoah and Great Smoky parks



The 100-mile Blue Ridge Mountain road *(below)* in Shenandoah Park



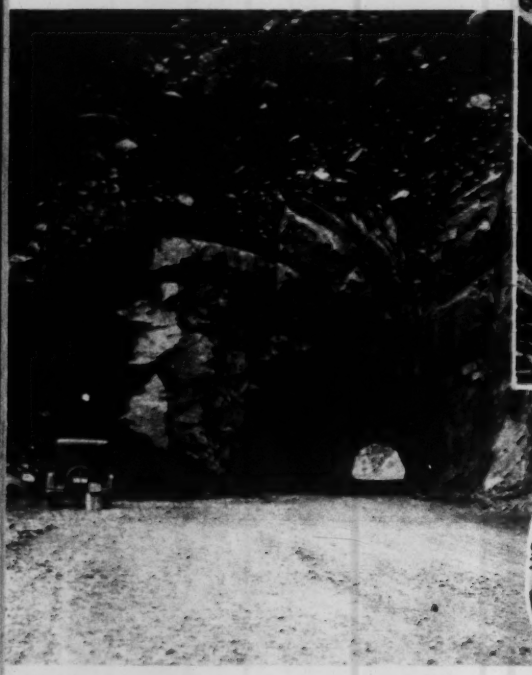
New roads *(below)* penetrating the heart of the Great Smoky Mountains



Roads and Structures in Shenandoah Park

Valley locations give occasional change of scenery

Mountainside locations give distant views over Shenandoah Valley



Spurs of rock are penetrated by two-lane tunnels

Hawksbill Mountain *(left)* from the Skyline Drive

Bridges are laid up by hand from native stone

Stone masonry is used for all main drainage structures

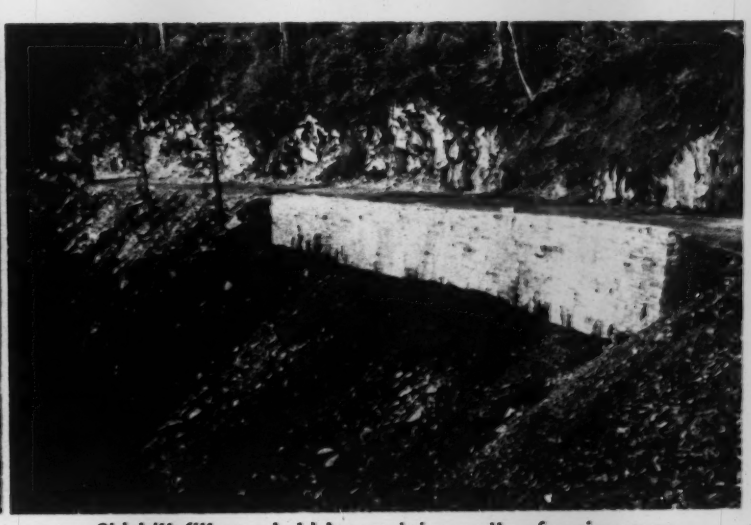
Revamping Old Road in the Great Smokies

Drilling cliff face to widen old narrow roadway

Old steep grades reduced by blasting down crests in thin layers

Old timber bridges *(below)* are all being replaced by stone arches

Tunnels replace winding sidehill locations



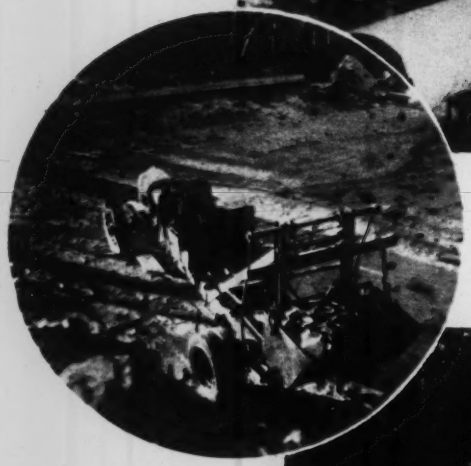
Sidehill fills are held by retaining walls of native stone

ENGINEERING NEWS-RECORD, JULY 25, 1935

Skyline Drive in the Great Smokies

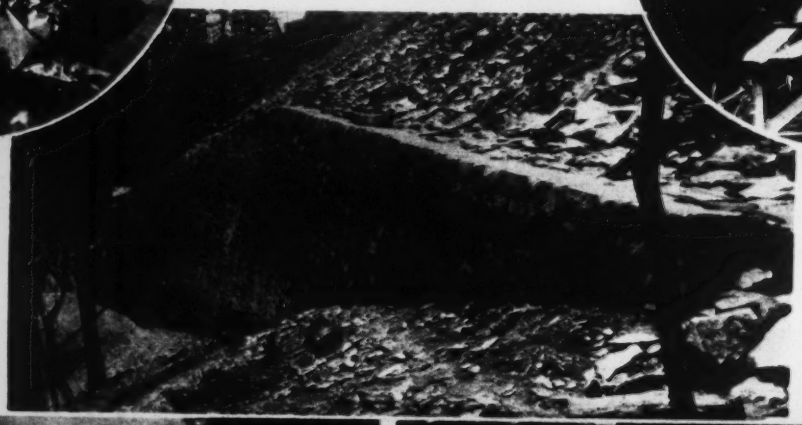
Dry rubble slope walls permit steeper fill slopes

Most fill slopes *(below)* are retained by vertical stone walls



Job-made rig for hauling stone to crusher

Sidehill staging permits use of wagon drills on steep slopes



Side-dump wagons are main hauling unit for grading

Surfacing stone spread by tail-dumping motor trucks

ticable to restrict the use of the proposed two-lane drive to passenger cars. The location in rugged topography dictates also curvature and grade which will not invite commercial traffic or the hurrying motorist. For this reason and the added fact that towns and cities will be widely skirted, the project will serve in the fullest sense a recreation purpose. It is expected that the tourists will be attracted by its scenic qualities in sufficient numbers to justify its construction.

An interesting feature of the work is the cooperation of the states of Virginia and North Carolina, which are now buying broad parkway land to be deeded to the United States. With additional protection in the form of scenic easements precluding billboards, unsightly building and the cutting of forest stands, the elongated parkway will average 1,000 ft. in width. This wide zone of control is considered a minimum for a drive largely predicated on the natural landscape values. The acquisition of this strip, particularly through the rural regions, constitutes without doubt the most stubborn problem to be encountered. It is especially hard to convince an owner that he must relinquish the old idea of frontage rights and access, or that the scenic easement will permit continued use of his farmland; the benefits that will accrue to the tourist trade and thus indirectly to the land owner are too intangible to be perceived. To the acquisition agency on the new project, therefore, will fall a large share of responsibility.

As a supplement to the parkway strip, existing federal land programs have been enlisted to purchase entire scenic features. These preservation areas will vary from several square miles, including whole mountains or groups of mountains to smaller acreages of historic interest. The parkway will be a road type to invite leisurely driving and frequent stops for a period of hours or of days by the vacationer. It is unquestionably desirable, therefore, to provide in these enlargements facilities for camping, hiking, horseback riding, fishing, swimming, and other active sports. Usage of the area in this manner will be encouraged, since the parkway itself cannot be closely related to many of the interesting features and cannot itself provide full enjoyment of the region.

Since the parkway will travel the less-developed zones, formerly inaccessible to the motorist, it is also necessary to provide for automobile service, food and lodging. There will, of course, be convenient connection by paved trans-mountain roads to the city accommodations and the established resorts, and at night many of the travelers will no doubt seek out these existing services.

Engineering Design—The new park-to-park road is being designed by the engineers of the U. S. Bureau of Public Roads in close collaboration with landscape architects of the National Park Service. This is in accordance with a nine-year inter-bureau agreement between the Secretaries of the Interior and of Agriculture by which the bureau is the agency for all major road construction in the national parks. In charge are H. J. Spelman, district engineer, reporting to Thomas H. MacDonald, chief of the bureau, and Thomas C. Vint, chief landscape architect of the park service under the office of director Arno B. Cammerer. About 300 miles of location have been determined, surveyed and pushed to final design state to meet unemployment needs. As soon as right-of-way is available, construction will be undertaken on several sections.

As is always the case in mountain roadbuilding, this project requires careful location study. There is the ever-present problem of fitting a high-standard alignment and grade to rugged mountainsides without undue construction scar. In this particular project there is the added objective of showing off the outstanding views without over-sacrificing the directionality of the route. To combine efforts to these ends, the closest cooperation is required between the location engineer and the architect. In a measure the length of the Shenandoah-to-Smokies Drive has made way for a new type of solution. Although a large part of any scenic parkway would desirably climb to the vast panoramas offered by a location high on the mountainsides, it is believed that 500 miles of such roadside would be overpowering or even tiresome. For this reason the designers have attempted to introduce a thoughtful variety of scenic type.

Contrary to the expectations of the public that the road would become an all-skyline location, whole sections have been projected along mountain streams and rivers, affording broadside views of the range itself. The development down from and back into the mountains also offers an appealing variety and interest. After this principle of a changing location had been accepted, it followed that the valley sections should be so selected as to avoid the mountains where a good road alignment could not be obtained. Usually, and happily, the alignment problem develops in the less significant sections of the range. It is unnecessary to point out to the trained man familiar with the conditions that the term "skyline" is a catch-phrase and a badly abused one. Ruling grades between gap controls make it impossible to locate for very long on the actual crest, an ideal to be striven for in moderation.

Much attention has been given by the Bureau of Public Roads to the maintenance of high standards of design. It is difficult to obtain this result consistently in view of balances on a 30-ft. grading section of 80,000 cu.yd. per mile in extreme cases. The effort, however, has been to keep well above standards now in use on other and shorter drives through mountain parks, which permit, in emergency, the 200-ft. curve and a restricted amount of 8 per cent grade. The use of tunnels and an occasional structure over ravines will contribute to the easy driving quality. Spiral curvature and superelevation will of course be applied in the design. It is also planned to eliminate grade-crossing of the principal highways. These factors plus the insulating effect of the broad right-of-way should reduce traffic hazards to a minimum.

Interpark Road Systems Progressing Actively

According to information obtained from the National Park Service, the Bureau of Public Roads and editors' visits to construction in progress

BEFORE the 400-mile interpark highway had hatched from a vision into actual possibility in the incubator of the Public Works Administration, road development had begun in both the Shenandoah and the Great Smoky Mountains national parks. Construction was begun in 1932 on about 32 miles of the 100-mile Skyline Drive along the crest of the Blue Ridge in Shenandoah Park, and since then construction has been continued and further construction is planned. The route and general construction characteristics of this road were described in *Engineering News-Record*, July 7, 1932. Meanwhile, in presenting the Great Smoky Mountains area to the National Park Service, North Carolina and Tennessee had provided an across-park highway, each state undertaking the construction of its boundary line.

The Skyline Drive in Shenandoah Park was and is a National Park Service undertaking, the Bureau of Public Roads acting as its engineering and construction agency, collaborating with the branch of plans and design of the National Park Service. Since the main route and construction characteristics have been described in the article just referred to, only the route map and characteristic structures are indicated.

In 1933 the park service began intra-park highway development in the Great Smoky Mountains park area. The map indicates the across-park road previously mentioned, the bordering state roads of North Carolina and Tennessee, and the new construction and reconstruction work with which this article is chiefly concerned.

A preliminary word is needed beforehand, however, concerning the park

territory. As indicated by the map, it is largely mountainous—in fact, the most massively mountainous of any land east of the Rocky Mountains. Roads of any kind penetrate only the borders of the territory; beyond these are mountain trails alone, and these soon merge into primeval forest. In the park area, 71 miles long and at most 20 miles wide, there are 200,000 acres of virgin timber. And this forest clothes a backbone and riblike ridges rising from a height of 1,000 ft. to peaks that reach 6,600-ft. elevation. Incidentally, while the park service is considering the opening up to travel of the part west of the across-park road, it expects to leave the eastern part largely untouched for the benefit of those who scorn roads and inns.

The intrapark road plan is still in the making. At present, the work definitely planned is improvement of the across-park road, and from where this road crosses the main ridge at Newfound Gap the construction of a drive west along the ridge to Clingmans Dome. In time the drive may go on to Deals Gap, a distance of about 30 miles. In 1934 reconstruction was begun on the Tennessee part of the across-park highway, and construction was begun on the drive west from Newfound Gap to Clingmans Dome. The new construction was let to contract, but the reconstruction is being carried out by force account under PWA allotment. Visits to these two operations in 1934 are the bases for the accounts of methods that follow.

Mountain Roadbuilding in the Great Smokies

A visitor's glimpse of roadbuliding by day-labor forces and by modern contract methods in Great Smoky Mountains National Park

THE BROAD CONTRAST between the two operations by which construction is going ahead is that the reconstruction work is being conducted largely by day labor without extensive power equipment and the new construction is being done by contract and is mechanized to an extent that is uncommon in isolated mountain roadbuilding.

Reconstruction Operations—Reconstruction is confined to the original Tennessee portion of the across-park highway. This road had an 18-ft. blacktop surface, 7 per cent grades and 35-ft. minimum-radius curves. Realignment and easement of grades were therefore major operations to meet the design objectives of the revamped road, which are 6 per cent maximum grade and curves with a minimum curve radius of 100 ft. on unobstructed sight distances, and of 200 ft. where sight distances are obstructed. On the old road all bridges were temporary timber structures; the new bridges are masonry. The old 18-ft. roadway is being widened to 20 ft., and cut-and-fill slopes are in many places replaced by slope or retaining walls of masonry and protected by guard-rails. The realignment also includes two tunnels, each about 200 ft. long.

The construction methods are a mixture of primitive and modern processes and equipment. For example, the tunnels, which require heavy timbering, are being drilled and blasted by modern methods and are being mucked by hand loading into mule carts. The carts hold only 6 to 8 cu.ft., and one sees a long string of these mule-pulled affairs, each mule led by a man, trudging along the grade for half a mile or so to and from fills being made of the tunnel muck. But the real concentrations of laborers were at the bridges, handsome stone-arch structures, where local stone was quarried and then cut by hand. The cutting and dressing were being beautifully done.

More generally, the construction operations appear favorably. Trucks and power shovels, some rented and some owned by the Bureau of Public Roads or the Park Service, are being used to advantage in the grading, which is, of course, the controlling operation. The grading too is of a mean character, skimming off a little here, building up a little there, widening and straightening a little at a time, all of which shows up more in array of men and tools than in yardage volumes. Withal, the finished work is splendid road construction; a travel route that no means of construction could improve in substantial beauty of structure.

Contract Construction Conditions—Contrasted with the day-labor reconstruction operations, the 7.6 miles of the Clingmans Dome Road under contract construction represents about the most modern procedure in roadbuilding. As shown by the map, the road takes off from the across-park road at Newfound Gap (El. 5,100) and follows practically the top of the main ridge of the Smoky Mountains, first on one side of the ridge and then on the other, crossing from Tennessee to North Carolina. In general, the road climbs steadily to reach an elevation of 6,300 ft. at its terminus. At present, this road goes only to Clingmans Dome, the highest mountain in the park, and connects with no other road, but it is the first step in any highway to Deals Gap. Because the road traverses the top of the ridges, there are no bridges throughout its entire length except one little structure that serves as both a drainage structure and a bridle-path underpass. All other drainage is provided by corrugated-iron culverts in deep places and concrete-arch culverts in places of shallow cover. Included in the contract is a parking space to accommodate 500 cars at Newfound Gap; this parking space is literally being dug out of solid rock, the rock being used for the crushed-stone surfacing of the new road.

The controlling conditions of this mountain road construction lie as much in the unusual specifications of the National Park Service as in the natural conditions. A few of the specification requirements will indicate the effect on construction procedure:

First of all, the vertical scar of the highway construction must be limited to 70 ft.—that is, from bottom to toe of fill on one side to the top of cut on the other side must not exceed this 70 ft. of vertical distance. This is one of the most troublesome requirements of the whole work, as much of the new road is along steep side slopes. Another requirement is that ground or vegetation, including trees, must not be disturbed outside the limits of the right-of-way. This has been interpreted so strictly that in case a tree off the right-of-way is barked by a flying rock, the contractor must have a tree surgeon treat the wound. It is also required that in felling trees for clearing the right-of-way, a big tree shall not be allowed to fall downhill, where it would crash into trees that are to be left standing. This is also a troublesome requirement when one realizes the difficulty of making some of these big spruce trees fall uphill.

Where the toe of a fill is just barely to meet a tree that is to be left standing, the contractor is required to build a retaining wall of stone around the tree to protect it from damage. In other places he has to lash a mattress of poles around the tree trunk to protect it.

The limit-of-vertical-scar clause requires the construction of a great number of stone retaining walls to keep the fill within the vertical-scar limit. These stone walls for the most part are cut stone masonry laid in cement mortar, and the requirements are that they be founded on solid rock. In one wall near the start of the job, 4,000 cu.yd. of stone masonry was required and the foundations went down 25 ft. below ground surface on a steep hillside. In other places the retaining walls are built in two vertical steps to cut down excessive height. Actually the construction of these retaining walls is the limiting item in progress of the work; they have to be completed ahead of the fill, and because of the topography of the country they are not accessible until some kind of a road is cut through to their sites. Toward the end of the job the contractor asked for permission to build some dry rubble walls out of fieldstone or stone that did not require dressing. The engineer consented in one or two cases, and one of the views shows the result. These slope walls are not nearly as nice looking as the cut-stone masonry struc-

tures, but they perhaps fit in better with the wild surroundings.

Naturally, because of the wild character of the country, access to new construction could be had only at the Newfound Gap end. This fact, coupled with the necessity of getting the retaining walls built as rapidly as possible, practically dictated the construction methods.

Contract Construction Methods—Clearing the right-of-way was extremely difficult on some of the steep slopes, as has been said before, because the trees had to be felled uphill. All wood had to be removed from the right-of-way, either by burning or by cutting it up into 5-ft. lengths and hauling it out; all merchantable timber was so cut and hauled out to a local box factory. Following the clearing gang was a gas shovel which cut through a pioneer road. The pioneer road was just road enough to get through to the various retaining-wall sites. It was a narrow cut and as narrow a fill as possible, and little attention was paid to final grade as long as work was done within the limits of the right-of-way. Portable compressors were moved along with the shovel for necessary drilling operations. Tractor trucks seemed to be favored for what haulage of material was necessary on the pioneer road construction.

The contractor devised an interesting arrangement for drilling, especially on the steep side slopes. The rock-cut work was extremely heavy, averaging about 60,000 cu.yd. per mile, and naturally required a tremendous lot of drilling. Jackhammer drills would have served the purpose but were considered too slow. Therefore the contractor used regular drifter drills mounted on wagons, and devised a side-hill trestle arrangement over which the wagon wheels could be operated. These trestles were nothing more than wooden horses with one set of legs longer than the other, which were placed on the hillside and carried plank runways over which the drills operated. This arrangement proved extremely effective, and each of the two wagon drills used averaged 55 ft. of drill hole per hour's operation, with as much as 640 ft. of holes drilled by one unit in an eight-hour day. Compressed air for these drills was supplied by two portable compressors, one gas-driven and the other oil-driven.

Following close behind the pioneer shovel was the stone-masonry crew. Stone for the retaining walls was secured from the right-of-way and was cut and trimmed by hand with the use of plugs and feathers. Light derricks of the stiff-leg variety and gin-pole guy derricks were placed at strategic points along the roadway and on the mountainside, to handle the pieces of cut stone into place. A small portable mixer was used for the mortar. The walls are beautifully built and were constructed at a rapid rate, considering the circumstances. Each retaining wall was designed according to local conditions, just as a bridge structure would have been designed. Trouble was experienced in several places in finding suitable rock foundations, and sheeted trenches were necessary to reach ledge rock.

The next operation was the construction of the final road. A 2-yd. steam shovel was the principal piece of equipment for this job. The wagon drills and jackhammers were used for what drilling was necessary, and cuts and fills were made with the aid of tractor trucks and by very effective units, consisting of a diesel crawler tractor hauling a 7-yd. side-dump wagon mounted on crawler treads. The steam shovel left the subgrade fairly smooth, and little final spreading was required. At times the contractor had difficulty in finding suitable soil to smooth off the subgrade.

The wearing surface of the road consists of two 6-in. layers of crushed stone, neither layer being rolled. The stone is crushed for the most part at a plant at Newfound Gap, some rock being supplied by cutting for the parking area. Another quarry was opened up, but the crusher plant was not moved.

While the main supply of rock for the crusher comes from the heavy cut, considerable material is being obtained from the leveling up process at the parking area. Several small hoppers or skips are disposed among the crews, who are blasting and cutting out small areas of rock. This rock is loaded into the hoppers by hand, and the hoppers are then picked up by a hoist on the rear end of an old truck, hauled to the crusher and dumped. The crushed stone is taken out along the road and dumped from trucks in the usual manner.

In connection with the soil required for leveling up the subgrade, the specifications provide that on the first cut this material should be stored and used later on as needed. However, the contractor found that he did not have sufficient storage space on the right-of-way, so much of the good soil was dumped directly into the fill and had to be borrowed elsewhere. Another cost item in the matter of drilling and blasting is that the contractor had to spring all drill holes because of requirements prohibiting shattering of rock outside the right-of-way limits.

Progress and Personnel—The contractor established a camp one mile up the road from Newfound Gap and located the usual blacksmith and repair shops there. Excessive wet weather has hampered progress considerably. Although the work was started late in 1933, it will not be finished until some time in 1935. In December, at the time the work was visited, the engineers had shut down all surfacing work because of the wet condition of the subgrade.

This contract, totaling nearly $700,000, is being done by The Arundel Corp., Baltimore, Md. J. V. Hogan is president of the corporation, and H. O. Firor is general superintendent of construction. W. H. Anderson is local superintendent for The Arundel Corporation, assisted by C. L. Rohde. Col. W. I. Lee, associate highway engineer, U.S.B.P.R., is in charge for the Park Service.

Higher Standards for Engineering Candidates

APPROACHING the question of limiting numbers in the engineering profession by emphasizing quality, Dr. Raymond Walters, president of the University of Cincinnati, in addressing the Society for the Promotion of Engineering Education at Atlanta on June 26, stated that if the criteria of expertness, personality and character are applied, there will be no flooding of the engineering field.

Quoting from data collected by a committee of the American Council on Education, he said that in 1930 there were 282,000 men engaged as technical engineers, representing an increase over 1920 of about 50 per cent, as compared with an increase of 16 per cent in the population for the decade. The per capita proportion in 1930 was one engineer for 425 persons; of those enrolled in the professional societies, there was approximately one engineer for 850 persons. In this same year there was one lawyer for every 762 of population and one physician for every 852.

Recording his personal opinion, Dr. Walters felt that the increase in the number of engineers has been disproportionate to population increase, but that if high standards are exacted for admittance to the profession the oversupply will disappear. Although the professional societies perform a valuable service in passing upon the qualification of mature individuals, the broad problem of qualification for engineering must be met earlier than these agencies can act.

Earlier selection is felt to be essential for the good of the profession as well as in justice to the mass of young candidates who enter educational institutions each year.

The engineering school is in a position to serve as the ideal selective agency, and upon it must fall the difficult rôle of judging and sifting candidates for the profession. No task facing a dean and faculty calls for more care, wisdom and humility, Dr. Walters declared.

Vierendeel Truss Bridges Popular in Belgium

Most recent highway and railway structures utilize the design characterized by "rigid panels" without diagonals introduced nearly 40 years ago by Professor Vierendeel—Both concrete and steel are used, with welding giving new impetus to steel

By Léon G. Rucquoi
Editor, L'Ossature Métallique, Brussels, Belgium

FIG. 1—FIRST WELDED Vierendeel truss, the Lanaye Bridge over Belgium's new Albert Canal. It has a span of 208 ft. and was shop-welded and field riveted, the field splices being located outside the joints.

WITHIN the past two years 25 Vierendeel bridges, entirely or partially assembled by welding, have been built by the department of bridges and highways of the Belgian State. At the same time the Belgian railroads have erected a number of riveted Vierendeel bridges, among which are the two largest spans of this type. Also many Vierendeel bridges have been built of reinforced concrete. The purpose of the present article is to review the development of the Vierendeel truss and to indicate the reasons for its wide adoption by the Belgian authorities for the majority of their recent bridges.

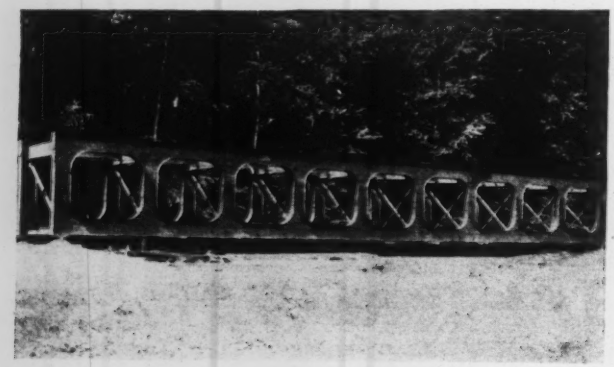
Professor A. Vierendeel, of the University of Louvain, when director of technical service of the province of West Flanders, was impressed by the inaccuracy and incorrectness of the methods used for the design of so-called "statically determinate" trusses. These trusses, although riveted, were calculated as pin-connected, so that the rigidity of the joints was neglected and no provision was made for secondary stresses. Professor Vierendeel proposed an entirely new type of truss, characterized by the elimination of the diagonals. (See "Longerons en Treillis et Longerons à Arcades," by A. Vierendeel, Lyon-Claesen, Brussels and Paris, 1897.) The greatest merit of the invention probably lies in the method of calculation derived by Professor Vierendeel, to determine accurately the stresses (moments, direct stress and shear) in the various members of his open-panel truss.

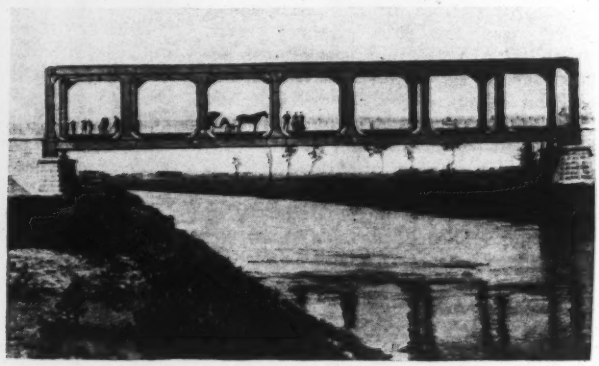
The first Vierendeel bridge was an experimental one built at the expense of the inventor in 1897, at Tervueren, near Brussels. This structure was subjected to various tests by two engineers of the state bridges and highways department, A. Lambin and P. Christophe. It was a 96-ft.-span riveted bridge designed to carry a single railroad track, and showed exceptional strength and rigidity. The tests were carried to final failure, which occurred under a uniformly distributed load of 445 tons, or 2.73 times the total live load assumed in the design. "In their official report, Lambin and Christophe (*Annales des Travaux Publics de Bélgique*, February, 1898) concluded that "In the present state of the question, the portal frame truss is, generally speaking, a system nearly equivalent to the triangulated truss."

Between that time and 1930 about 30 Vierendeel bridges were built in Belgium, both for railroad and highway service. Also in the Belgian Congo, between 1923 and 1931, 23 railroad bridges of this type were constructed, the longest being the Bushimaie bridge with a span of 220 ft.

The weight of Vierendeel steel trusses, especially for longer spans, is less than that of ordinary triangulated trusses; it is often much less when higher working stresses are allowed, as a result of the more accurate methods used for their design. In spite of this advantage, the difficulty in fabricating the rounded gusset plates at the joints proved an obstacle to the early acceptance of the steel Vierendeel truss. For a time the future of Vierendeel trusses seemed to rely more on reinforced concrete than on steel; stiffness of members and of joints

FIG. 2—PIONEER Vierendeel bridges. Left: test bridge of 96-ft. span built in 1897, which failed under a load 2.73 times the assumed single-track railway live load. Right: first bridge for actual service was a 128-ft. span structure built at Avelghem in 1901. It was destroyed during the war.





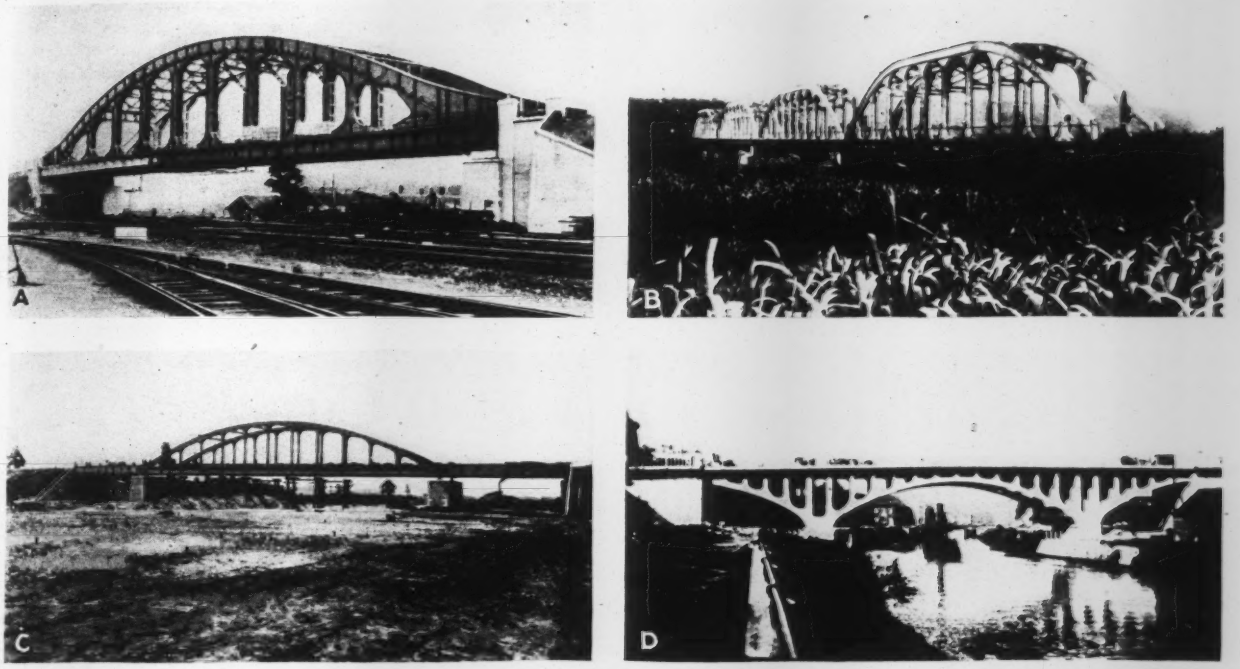


FIG. 3—VIERENDEEL BRIDGES for railway and highway service. A: Double-track riveted railroad bridge at Malines whose 274-ft. span is largest yet built in this design. B: Bukama railroad bridge in Belgium Congo built in 1925 and consisting of four 189-ft. riveted spans. C: First all-welded Vierendeel bridge, built in 1934, and spanning 175 ft. over the Albert Canal at Herenthals. D: Concrete Vierendeel bridge over the Schelde River near Tournai consisting of a 95-ft. central span and 40-ft. side spans.

in reinforced-concrete construction permitted close conformance to design theory, and the large rounded joints did not present a special complication either for building the forms or for placing the reinforcing bars. Many Vierendeel trusses were successfully built in reinforced concrete.

The advent of electric arc-welding finally made the steel Vierendel truss a complete success. In 1932 the bid for the first welded Vierendeel bridge was awarded to the Société Métallurgique d'Enghien Saint Eloi in Belgium for the fabrication of the 208-ft. span Lanaye Bridge over the Albert Canal (*L'Ossature Métallique*, No. 2, 1933, p. 57). Experience with this bridge was so satisfactory that most of the new steel bridges built by the department of bridges and highways are of the Vierendeel type, some being only shop-welded while the latest are both shop and field-welded. The table gives

WELDED VIERENDEEL BRIDGES IN BELGIUM

	Location	Built	Span, Ft.	Trusses, Ft., C. to C.	Number of Panels	Max. Depth C. to C. of Chords, Ft.	Type of Field Joints[1]	Weight of Span, Tons[2]	Weight of Trusses, Tons
1	Lanaye (Albert Canal)	1932–1933	208	29	12	28.3	riveted	309	187
2	Schooten near Antwerp No. 39 (Albert Canal)	1933	192	29	12	26.2	riveted	295	166
3	Schooten near Antwerp No. 40 (Albert Canal)								
4	Herenthals "C" (Albert Canal)	1934	175	29	12	24.4	welded	222	121
5	Lanaken-Smeermaas (Briegden-Neerharen Canal)	1934	166	29.6	10	23	riveted	200	146
6	Lanklaar (Zuidwillemsvaart								
7	Bocholt I (Junction Canal Meuse R. to Schelde R.)	1934	167.5	17.1	10	19.8	welded	133.5	59.5
8	Eisden II—(Zuidwillemsvaart)	1934	149	26.5	10	21.7	welded	145	94.3
9	Dilsen "								
10	Neeroeteren "								
11	Brée "								
12	Bocholt II "								
13	Kaulille (Junction Canal Meuse R. to Schelde R.)								
14	Lille-St. Hubert " " " " "								
15	Lommel No. 9 " " " " "								
16	Lommel No. 12 " " " " "								
17	Herenthals "A" (Albert Canal)	1934	149	29	10	22.9	welded	181	99
18	Gheel No. 18 (Albert Canal)	1934	149	15.3	10	16.8	welded	95	62.7
19	Gheel No. 19 "								
20	Oolen No. 20 "								
21	Herenthals No. 21 "								
22	Dudzeele No. 1 (parallel canals of Selzaete and	1934	104.5	29.6	8	13.9	welded	108	56
23	Dudzeele No. 2 Schipdonck)								
24	Zutendael (Albert Canal)	1935	236	29	12	28	welded	448	233
25	Gheel No. 17 (Junction Canal Meuse R. to Schelde R.)	1935	148	29.6	10	23.6	welded	214.5	140
26	Mol No. 14 " " " " "							241	162

[1]All spans are shop-welded.
[2]Tons of 2,000 lb.
Note—Bridges 1 to 21 incl. are highway structures; 22 to 26 are railroad bridges.

the location, spans, weights, etc., of the welded Vierendeel bridges recently completed in Belgium.

Welding (and flame-cutting) applied to the Vierendeel trusses made the fabrication of the members and the joints much easier. Members are generally either rolled or built-up H-sections. Welds are continuous. Laboratory tests on Vierendeel joints conducted in the Universities of Liége and of Brussels by Professors F. Campus and H. Dustin, have indicated both the perfect agreement between Vierendeel's method of design and the actual stresses in the various sections, and the remarkable resistance of the joints to dynamic stresses.

The Belgian railroads have recently built a number of riveted Vierendeel bridges, among which two, in Herenthals over the Albert Canal, are notable. Each has a span of 274 ft. One carries a double track, the other a single track. Also, in Malines, on the new Brussels-Antwerp electric line, there is a 274-ft.-span double-track bridge. Welding has not yet been adopted for the bridges built by the Belgian railroads, although the question is receiving serious attention, and additional tests are being made on the behavior of welds under dynamic loadings.

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Sewerage Planned for a 1970 City at Cedar Rapids, Iowa

Forecasting based on city plan and zoning ordinance of progressive Iowa city provides intercepting-sewer system anticipated to be adequate when 40 more years of growth in business and population has accumulated

A CONTINUOUS PROGRAM of sanitary-sewer and sewage-works construction, which has been in progress since 1929, is now drawing to a close at Cedar Rapids, Iowa. As a design and construction problem this work divides naturally into treatment-works operations and into sewerage operations. The sewerage operations, or, more specifically, the intercepting-sewer construction, are alone considered here. These have special interest because of construction methods, the adoption generally of precast concrete pipe and a plan based on a definite city plan and zoning laws, which indicated the probable trend and growth of business and home occupancy for a 40-year period.

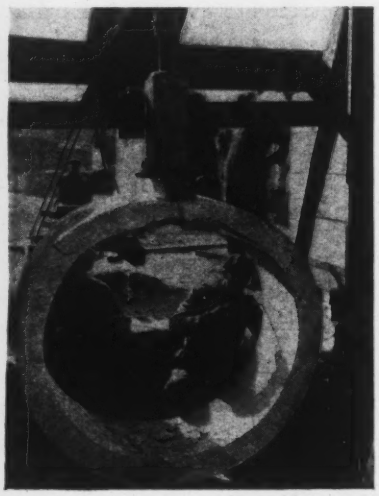
General sewerage conditions

Cedar Rapids, with a population of 56,000, is typically a Midwestern city with perhaps more food-products manufacturing establishments than the average; annually 65,000,000 bu. of grain are milled and 1,000,000 head of livestock are butchered. The population growth has been uniform at 2.9 per cent per year since 1900, and a forecast of 170,000 population as of 1970 was used for the purposes of the intercepting-sewer design. Due to the nature of industries that would naturally gravitate to a community of this type and to the fact that such industries are usually large producers of high-concentration waste, the difficulties of a long-time forecast of demands are obvious.

Fortunately the available areas for future industrial development that are convenient to the river for water supply and to railroads for track service are downstream rather than upstream of the city. Therefore, the probability that new industries producing large volumes of waste may overload the new intercepter through the city is remote, and any additions to the intercepter will be short and of minor importance. The commercial and industrial sections of the town are on moderately low land adjacent to the Cedar River, the residential sections being on high elevations. The maximum variation between street levels is about 160 ft.

In general, the city is served by two complete separate sewer systems, one for the east and one for the west side of the river. Therefore, the forecast as to future direction of growth was important, and the existing definite city planning and zoning ordinances were of material value in suggesting the direction and control of future growth. According to the past history of the city the increase in population, as well as the establishment of trade-waste-producing industries, has been uniform on each side of the river and divided about 60 per cent east and 40 per cent west.

FIG. 1—COMPLETING a test on 48-in. ring of precast concrete pipe, which failed under a load of 12,255 lb.



In 1886 construction was started on the first East Side intercepting sewer. It paralleled the river a block and a half away and picked up all the laterals which prior to that time discharged directly into the river at each street end. This old intercepter throughout its lower reaches deserves notice because it was one of the earliest precast concrete pipe jobs. It is egg-shaped, of two sizes, 24x32 in. and 12x22 in., 3 in. thick and has bell-and-spigot joints.

Frank Barta, superintendent of sewers for 45 years, states that the concrete pipe was built in 1887 by contract under Mr. Mitchell, city engineer. The sections were built in wooden forms, split so that they could be removed after 48 hours, and then the pipe was kept at least 30 days in storage and sprinkled daily. Milwaukee natural cement was used since portland, although available, cost too much—$6 a barrel. The proportions are not known, but a rich mix was used with an aggregate of one-third natural sharp sand and two-thirds gravel. Mixing was by hand, and the mix was only moist; tamping was thorough. No failures of any kind have appeared on the larger-sized pipe, but 150 ft. of the smaller size, laid late in the season and given a shorter curing than 30 days, collapsed immediately after backfilling and was removed and replaced at once. Mr. Barta says in the 45 years he has been in charge of sewers he has never had any occasion to repair the line which until five years ago, when it was supplemented by another line, carried all of the East Side sewage of the city. Velocity and flowage tests in

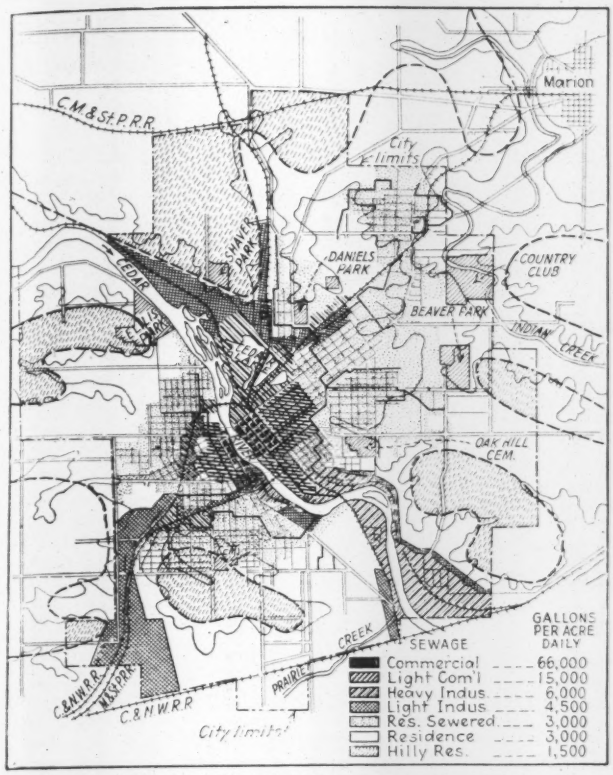


FIG. 2—PRESENT AND FUTURE occupancy and sewage flows. Types of development expected within 40-year design period, as indicated by existing zoning laws, are altered to conform with estimates of changes expected.

FIG. 3—BASE MAP showing intercepters and drainage areas. Upon this map, occupancy was superimposed to get area occupancies and probable flows, thus determining logical points of discharge into intercepter system.

1928 indicated a coefficient of friction of 0.011 (n in Kutter's). Upon investigation this sewer, although overloaded, was found to be in good condition, which established the fact that the sewage characteristics were such that a continuance of the use of concrete was not hazardous.

Adopted bases of design

As a basis for design, a topographical plat of the city was prepared, and the area within each natural contributing watershed was determined, as well as the most convenient point for each submain serving such area to enter the intercepting sewer. An estimate was then made of the probable changes in zoning ordinances throughout the next 40-year period, and the type and extent of occupancy of each drainage area were estimated. These determinations are indicated by Figs. 2 and 3.

A detailed examination was made of the quantity of sewage now originating in areas of typical occupation, and these rates of flow on a gallons-per-acre-per-day (g.p.a.d.) basis were applied to the areas before mentioned. These maximum rates were as shown on the map.

To determine the amount of infiltration which might be expected, existing main sewers were gaged during alternate wet and dry weeks. The water consumption in the districts in question was deducted therefrom, with a result that provision for 1,058 g.p.a.d. was found necessary, this figure being equivalent to approximately 70 gal. per capita per day. In the East Side system the rate of infiltration was found to be equivalent to 35,000 gal. per day per mile of sewer main and lateral, and 9,150 gal. per mile per day of actual pipe lines, including house connections, since there are 2.8 ft. of service lines per foot of main and lateral sewer.

The preliminary layout included not only intercepting sewers for early construction but sub-mains and laterals for later construction where future development would overload existing facilities. Probable population density was taken into consideration in making these tentative layouts. The maximum population density in residence districts was found to be 20 per acre, and this figure was adopted for short laterals, while a population of 15 per acre was used on long laterals where the evening effect of distance on peak loads would be felt.

Investigation of seasonal, daily and hourly variations in rate of sewage flow indicated the necessity for providing a capacity of 195 gal. per capita per day, to cover maximum variations in sanitary sewage flow plus infiltration.

Rerouting and design

A 48-in. intercepting sewer was deemed adequate for the East Side situation. Its route closely paralleled the original intercepter, leaving the old unit in service to care for the four- to five-block width of commercial district. The new line cut off all contributing laterals two blocks away from the old sewer throughout the business section. It was found that to get closer to the old intercepter with the new line an important business street would be occupied for construction purposes, throwing the streetcar line out of service temporarily and otherwise embarrassing traffic and business. To locate the sewer as finally built, two blocks away from the old intercepter, involved following a street occupied its full width by the tracks of four trunk-line railways. Therefore, for the 2,700-ft. of length involved, sewer in tunnel was planned; the average depth throughout this section was about 26 ft.

A careful analysis was made of existing superloads from railroad traffic at street grade, and consideration was also given to the probability of future track elevation with retaining-wall footings and earthfill further contributing to the superload. The reinforced-concrete pipe used, except as noted later, was 48 in. in inside diameter, with shell thicknesses of 5, 6½ and 6½ in. The reinforcement used was cold-drawn steel mesh, placed elliptically and having transverse square-inch areas per foot of length of 0.29, 0.30 and 0.40, designed for ultimate load in pounds per foot, using three-edge bearing, of 8,833, 12,250 and 16,000 lb. respectively.

FIG. 4—TYPICAL TUNNEL SECTION in wet sand. Poling boards and wild hay prevent entrance of semi-liquid sand; 3 m.g.d. was pumped from this heading.

The specifications required that an 18-in. length of pipe should be made each day for testing, and a lever-arm machine was constructed to test these ring samples. The pipe was field-made in cold weather, using heated materials and curing the cast pipe in live steam under canvas at a curing temperature of 75 deg. or more for 72 hours. In all cases test rings showed first crack at about 50 per cent of the ultimate load and exceeded the designed strength.

Check tests of cylinders and beams of the concrete used in the pipe were also made each day in duplicate. Half of the samples were kept under steam for 72 hours along with the pipe and were then thrown out into the air (temperature from 0 to 25 deg. F.), along with the pipe. The other half of the samples were kept heated for seven days. All were tested by standard methods, and it was found that there was no material advantage in curing under steam for more than 72 hours. The average 28-day compressive strength of concrete, using 2.04 bbl. of cement per cubic yard with crushed limestone for coarse aggregate, was about 4,750 lb. per sq.in. So far as the beam tests were concerned, they were disappointing. The modulus of rupture determined was in no way ratable or parallel to the compressive strength determined by standard cylinders from identical batches of concrete.

Tunneling methods

Due to the location of the finished conduit directly under the railway tracks, it was necessary to build working shafts from 12 to 25 ft. off line and to drift in under the tracks. The shafts, 600 ft. apart, were 30 ft. deep (the extra depth being provided for a pump pit during construction). A service tunnel was then constructed out to the line of the sewer tunnel, right angles turned and operations carried on in both directions. At the six points where headings were holed through, the maximum error was 0.6 in. in spite of the fact that angles and curves occurred at three points underground and the maximum base line (transferred from the surface down by 50-lb. weights hung on piano wire) was only 6 ft.

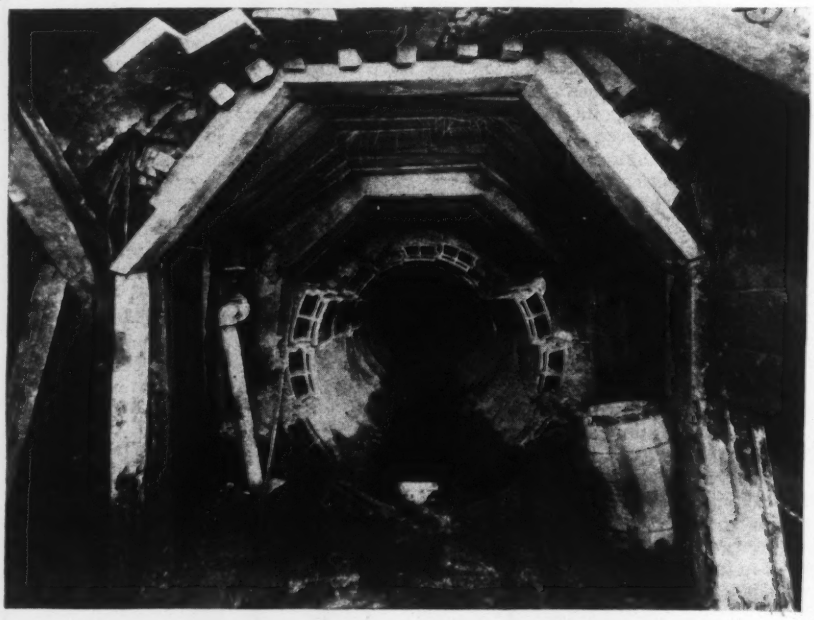
Five-piece sets of 2x6-in. maple heart lumber were used to timber the bore tightly. A standard system of breast boards and poling boards (Fig. 4) was used where the material was wet and caving. Starting at the south end of the tunnel and working north, the first 300 ft. had a blue clay bottom with wet sand on top, then the level of the clay gradually rose until at a point 1,000 ft. from the end of the tunnel the bore was entirely in blue clay. Near this point limestone was encountered in the floor of the tunnel, the level of which gradually increased until the bore was entirely in limestone. Where rock base and clay or earth roof was encountered, it was necessary to drive the tunnel ahead on top of the rock, timber the roof so exposed and then shoot out the rock beneath until the required depth had been reached.

Throughout the extent of the tunnel where wet materials were encountered, it was deemed advisable to finish the sewer conduit as quickly as possible. This precluded the use of precast concrete pipe, which could be used only where a section of tunnel was opened up from shaft to shaft. Therefore, single-ring, vitrified clay, segmental blocks were used (Fig. 5) laid in rich cement mortar and backfilled on all sides in not less than 6 in. of cement concrete of lean mix. Under ideal curing conditions this concrete set up rapidly. Where the tunnel was in rock, no conduit was put in place until the bore was completed from shaft to shaft, and then the standard reinforced concrete pipe was used, slid in on timber skids and backfilled with lean concrete.

Crossing lake margin

Another interesting section of work was a 1,500-ft. crossing of Cedar Lake,

FIG. 5—SEGMENTAL BLOCK in wet tunnel backed with 6 in. of concrete. Building footings are but 15 ft. upward and to left of tunnel, making careful work necessary not to undermine the footing.



using open-trench construction in a railroad fill (Fig. 6). The material immediately below grade of the conduit was a putty-like black muck, into which a bar could be thrust 10 ft. or more by hand. The upper cut was through junk fill. The depth of the trench through this section was from 8 to 10 ft. The water line of the lake adjacent to the fill was about 5 ft. above grade. The fill was so porous that large quantities of water flowed into the trench continuously. After the trench had been opened down to the water line, 2-in. plank sheeting guided by two sets of 6x6-in. waling and spread by 6x6-in. struts was driven to a point at least 5 ft. below grade. The excavation was continued, using power shovels, down to a foot below grade. Not more than a

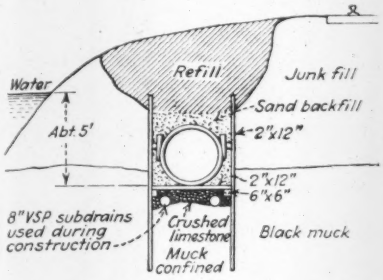


FIG. 6—PRECAST PIPE in lake crossing laid on timber floor and stone, with timber sheeting to confine the muck.

100-ft. section of work was undertaken at a time.

Two 8-in. vitrified sewer pipe subdrain lines were laid on the bottom of the excavation and were conducted to a sump at the end of each section. Self-priming centrifugal pumps removed the water at the rate of about 3 m.g.d. per section. Crushed limestone was then dumped in, over and around the subdrains, and tamped into position up to and within 2 in. of the bottom of pipe. On this rock a 2-in. plank floor was laid, tightly wedged between the side sheeting and was firmly spiked to wales secured to the side sheeting (Fig. 6). This planking provided a dry and clean working floor upon which the reinforced-concrete pipe was laid with carefully cemented joints. A 6x6-in. stringer was laid along each side of the pipe at the mid-line against the side sheeting, and wedges were driven between it and the pipe to provide stability for the sheeting as well as side resistance for the pipe. Excess yellow sand from other parts of the project were hauled in and backfilled around the pipe up to a point at least 1 ft. over its top. The top of the sheeting on the completed job was about 2 ft. above the top of the pipe, all of which construction was left in place as ordinary backfilling progressed. The finished structure therefore was an H-shaped timber box confining the muck below the line and providing insurance against settlement out of line. This line was tested for infiltration after it was completed, and even though all visible seepage points at joints were recalked with lead wool, the infiltration rate was found to be 17 gal. per linear-foot of finished conduit per day (2½ times average infiltration in the entire 100-mile system), which was considered satisfactory.

Costs of sewer work

The total contract sum on the East Side intercepter without river crossing was $312,000. The unit prices per foot of the larger conduits were bid in as follows:

48-in. concrete pipe in open trench, average depth 18 ft.	$15
48-in. segmental block sewer in wet tunnel	45
42-in. segmental block sewer in clay and rock tunnel	30
36-in. reinforced-concrete pipe across Cedar Lake without sheeting	19
Extra work on 1,500 ft. of lake crossing (cost plus 15 per cent)	4.80

The cost of the river crossing, which consisted of two 30-in. cast-iron inverted siphons, following the bed of the river and encased in concrete, with a total length of 575 ft. and equipped with concrete control chambers at each end, was $25,000. The cost of the West Side intercepter was about $40,000. The total cost of the intercepting sewers and river crossing was therefore about $400,000, including engineering costs.

The East Side intercepter was built by Gjellefald Construction Co., Forest City, Ia., with John Brogan and Sons, Green Bay, Wis., as subcontractor on the tunnel work. Christensen Construction Co., Cedar Rapids, built the West Side intercepter and river crossing.

This project was designed by Howard R. Green Co., consulting engineers, Cedar Rapids, who, with F. E. Young, city engineer, jointly supervised the construction.

Elimination of Cross-Connection Hazards Through Systematic Surveys

MORE systematic methods of surveying cross-connections were championed at a recent meeting of the New England Water Works Association by Warren J. Scott, director of the bureau of sanitary engineering, Connecticut department of health.

In a paper on this topic Mr. Scott pointed out that while much useful work has been done toward eliminating hazards arising from the introduction of polluted water into distributing systems of buildings through such connections, many connections remain obscure and constitute a threat to health. The state sanitary code permits no new cross-connections, but many remain from previous installation or from changes in piping effected after former survey work.

Aside from plumbing connections, the most common causes are industrial-process water supplies, auxiliary fire supplies in industrial plants, pump priming, auxiliary feed for boilers and private well supplies. In the case of private drinking-water supplies cross-connected with public systems, Connecticut does not require separation if the private supply tests safe, although separation is strongly recommended. Public water-supply managements can insist on separation on the basis that they have no control over the private supplies, and where swing connections are used both supplies cannot be connected at once. Periodic surveys are advised by the health department.

In making cross-connection surveys the first task is to trace locations of auxiliary water supplies. In some areas groundwater sources from driven wells may be of doubtful quality, especially in thickly populated districts. Local well drillers are a possible source of information, as are return postal cards to consumers. On large systems, Mr. Scott declared, it would be no extravagance to assign one or more men to the specific duty of making surveys of cross-connections, especially where numerous private supplies exist. Contamination of industrial-water tank supplies through leakage of water discharged from sewers is a potential hazard. A case occurring in connection with water-storage tanks was cited wherein a swimming pool was drained to a combined sewer, and on one occasion when the drain valve was opened sewage backed up into the pool from the sewer, which happened to be flowing under pressure after a storm.

Industrial-plant piping systems are often too complicated to be surveyed visually from the cross-connection viewpoint. Questioning of the master mechanic or other responsible official, and reference to maps prepared by fire insurance interests are frequently helpful in tracing the larger lines.

It was recommended that waterworks managements should frequently collect samples from distribution systems for bacteriological examination, select various sampling points, and follow up occasional poor samples to see whether near-by cross-connections, due to faulty plumbing, might be responsible. In closing, the speaker said that as much attention should be given to the dangers of pollution of distribution systems by cross-connections as to dangers of pollution of watersheds, since many of the recent serious water-borne epidemics have been due to faulty connections.

Dust Storms Had Little Effect on Highway Maintenance

Keeping motorized equipment clean, removing snow fences from dust drifts, clearing ends of drains and occasional surface blading were principal requirements

DUST-FILLED ROAD DITCHES in most instances cleared themselves as soon as heavy rains required their operation.

THE dust-storm troubles of the road engineers of Kansas, Colorado and other states have given way to those of rain and flood, and temporarily at least the newer conditions have solved the older problems. But while they endured, dust storms presented a real road-maintenance task, and of course they may come again and call upon past experience for its records of practice. These have proved on inquiry to be less informative than was anticipated; they do indicate, however, that road-maintenance problems of dust storms were not a major engineering difficulty. The following statements of experience cover the main observed facts. In connection with them the engineer will find interest in the more general account of dust storms by Professor Throckmorton in *Engineering News-Record*, May 9, 1935.

Equipment and Drift Problems in Kansas

By Ira E. Taylor

Engineer of Maintenance, State Highway Commission, Topeka, Kan.

THE MAINTENANCE of motorized equipment in the dust areas was probably of greater concern than any actual damage to the road surface or ditches. The Kansas state highway department equips all of its trucks, passenger cars and other power machinery with oil-bath air filters as a precaution against dust entering the motors. A practice was also inaugurated in the dust regions whereby crankcase oils were changed at least once each day and the oil-bath air filters thoroughly cleaned at the same periods; extra precautions were also taken carefully to inspect connecting rods and main bearings weekly, and then make any adjustments that might have become necessary due to excessive wear. Instructions were also given that equipment be operated at very nominal speeds during stormy periods and that no units be used during times when no probable good could be accomplished.

The routine protection of the lubricating systems of motorized equipment was also followed by proper cleaning and inspection of distributors, magnetos and fuel lines. The commission maintains and operates several hundred units of automobiles, trucks, tractors and motor graders in the so-called dust area, and by diligently pursuing the policies outlined in reference to the care of equipment, it avoided serious losses to motors and other working parts of machinery.

The actual damage to surface and drainage consisted largely of the filling of ditches and culverts with fine silt and the mixing of excess fine materials with the sand-gravel windrows that the department maintains for reserve materials on lighter-surfaced roads.

Most of the dusty periods occurred during the winter and early spring months while snow fences were still in place about 100 ft. north of the right-of-way fences on the east-west highways. These fences were completely covered with dust drifts in many areas, and some difficulties were encountered in removing the fences so that the drifts might be leveled down to prevent damage to the adjacent land. In a number of cases these slat-type fences had to be removed with portable hoists and other devices that were designed by the local maintenance supervisors. After removing the fence, the drifts were leveled with tractor and blade or by teams and harrows. However, it was found in many cases that after the removal of the fences, the wind removed the drifts and distributed them elsewhere.

The closing of drainage ditches and structures it was thought at first would be a serious problem, but by cleaning out the accumulated dust around the entrances and exits it developed that the heavy rains which followed the dust carried most of it through the structures and out on the fields in a somewhat uniform manner. In some extreme cases dust drifts interfered with the traffic on the highways, but generally speaking the snow fences obstructed most of the moving soil, and very little trouble in the driving surface from this source was encountered.

Actual damages, measured in cash expenditures to the maintenance department, were nominal, and the extra cost was largely offset by decreased maintenance operations due to the dry period. Very little surface maintenance was necessary or desirable during these winter months, and this decreased expense practically offset the extra cost of removing snow fences and the cleaning of ditches and drainage structures.

Probably the most serious effect of the dust-storm periods was the creation of a hazard due to extremely short visibility and uncomfortable atmospheric conditions. Those who found it necessary to attempt to travel on the highways during these times were confronted not only with the danger of colliding with another vehicle or running off the highway, but also with the possibility of motor failure due to the accumulation of dust in the working parts of the machine, or to so-called "static," which was sometimes present during these storms. The difficulty of reading highway signs was another hazard presented during these dust storms. In some instances where light showers did occur, followed by dusty periods, the signs became almost obliterated by an accumulation of dust, making it impossible to read either the route number or the directional information.

In summarizing this whole situation, it might be said that the most serious problems confronting the highway commission during the stormy periods were the proper maintenance of highway equipment and the concern for the safety of those motorists and truck operators who continued to travel on the state highway system during these periods of dangerous driving.

The dust-storm area was confined largely to the western sections of the state and affected less than one-fourth of the Kansas lands and agricultural activities.

Clearing Easily Done by Grader in Colorado

By O. T. Reedy

Senior Assistant Engineer, State Highway Dept., Denver, Colo.

NONE of the federal-aid roads was seriously damaged by the spring dust storms. A few places, not more than 10 miles, had dust deposited 4 or 5 in. thick, but this was easily removed with a grader. Some of the borrow-pits were partly filled and required

cleaning out with a grader to facilitate drainage.

Most of the pictures that have been published of Colorado roads that were damaged by the dust have shown side roads, little used, and in one or two instances even abandoned. The wide open principal highways were not very much hurt.

The most serious trouble in connection with the dust storms was the low visibility. Interference with operations of the graders was not serious, since it was necessary to keep the roads cleaned up while the storms prevailed.

Designing Breakwater Foundations Against Wave Scour

Better fortification of rubble mound bases against wave action indicated by failure of Algiers breakwater—New structures at Haifa and Dunkirk show trend toward strong encasement of light stone fills

THE frequent open-sea harbors of European countries and their dependencies have called for exceptional attention by foreign engineers to breakwater design to resist the attack of storm waves. Two of the most recent of these designs and the failure of an older but modern design are described in recent issues of British engineering journals, and from them the following descriptions have been taken. In the case of the Algiers breakwater, which was destroyed by storm waves, analyses are offered that open up new fields of conjecture concerning depths at which wave action may act destructively in dislodging foundation fills of rock.

Rubble foundation failure wrecks Algiers breakwater

Evidence of the need of increased scrutiny of foundation conditions is furnished by the failure a year ago (Feb. 3, 1934) of about two-thirds (1,315 ft.) of the newest portion of the system of breakwaters at the port of Algiers, on the north coast of Africa. The new structure, 1,968 ft. long, was designed by the French engineers, with intensive studies and computations of wave impact, as it was to be exposed to the unusual power of an open sea in the direct path of prevailing storms on a shore with rapid declivity to deep water and thus favorable to undiminished wave violence. As a barrier to direct wave forces the breakwater had apparently the qualities expected of it, according to studies of the failure made by Bryson Cunningham, M. Inst. C.E., and reported in *Engineering*, Jan. 11, 1935. This account, which was verified by M. Rénaud, chief engineer and director of the port of Algiers, is the source of the information for this article.

Structure and Storm—The construction of the section of breakwater that failed is shown by the accompanying drawing. The outstanding features are the depths, the sand bottom, and the main foundation of quarry débris of 6½-lb. to 440-lb. stone protected with riprap stone weighing a minimum of 8 cwt. The wall proper, Mr. Cunningham describes as follows:

> The bulk of the wall was formed of four vertical tiers of blocks, of a length equal to the full width of the mole and of an average height and width of 13 ft. The blocks in the lowermost layer were larger than the rest (though not so high), weighing 450 tons apiece, as against 400 tons in the upper course. The sides of the blocks were joggled so as to form a horizontal bond, while vertically, the blocks were connected by the reinforced-concrete filling of the vertical grooves provided for the purpose of handling and setting the blocks. The whole was surmounted by a capping of mass concrete forming a level platform 6.40 m. wide on the harbor side, with a parapet wall in two stages on the outer side rising to a height of 6.50 m. above zero.

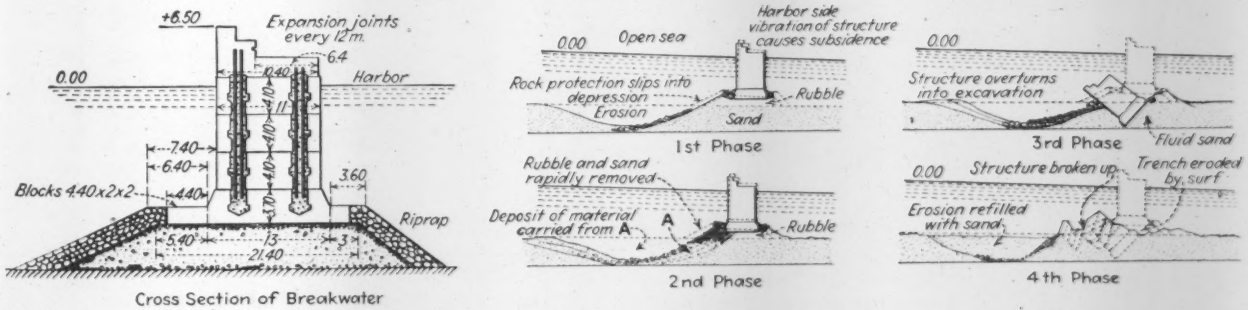
The storm that reached the intensity that caused failure on Feb. 3 developed rapidly, beginning to be violent on Feb. 2. At storm height, observations taken by the port authorities showed on Feb. 2 a wave length of 410 ft., and a period of 9½ sec.; on Feb. 3 a wave length of 656 ft. and a period of 13½ sec. The heights of waves on the respective dates were 12 and 30 ft. Both height and short periodicity are notable and are exceeded by only a few storms.

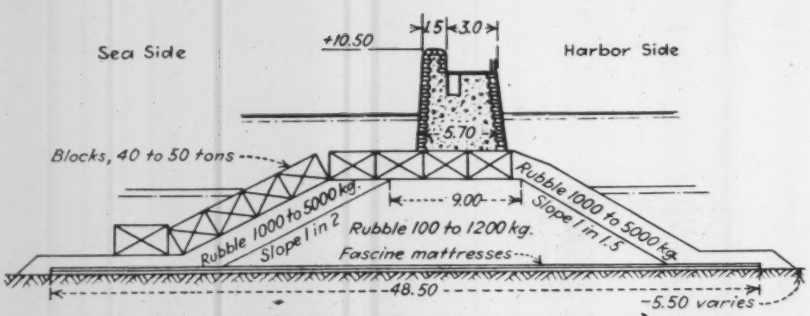
Foundation Failure—Commenting on the construction described, Mr. Cunningham states:

> There is no reason to believe that the design of the wall had anything to do with its collapse, or that there was any inability to resist the direct dynamic impact of wave action. The failure is essentially and fundamentally attributed to the undermining by suction of the rubble foundation. Experiments carried out at the Hydrological Laboratory at Lausanne, with a model on a reduced scale corresponding to a wave length of 200 m. and a wave height of 9 m., showed that even in this very extreme case there was still a factor of safety of 1.2 against overturning inward and of 1.53 against similar movement in an outward direction.

The progress of the undermining action is indicated by the port engineer, M. Renaud, to have been in four phases as shown by the accompanying drawings: (1) A slow but progressive movement, producing erosion at the foot of the mound and resulting in gradual displacement of the protective covering blocks; vibration of the superstructure on the foundation was set up, causing subsidence and slight displacement out-

ALGIERS BREAKWATER, showing section and progress of scouring action that undermined 1,316 ft. of structure in the storm of Feb. 3, 1934.





RUBBLE-MOUND FOUNDATION of Dunkirk jetty deposited on fascine mattress and held down with heavy precast concrete blocks.

wards. (2) This phase was abrupt and short; the large protective blocks having slipped into the hole formed by backdraft, the outer portion of the rubble foundation disappeared suddenly under the influence of a great wave, or, more likely, of two or three successive waves, the material being far too light to resist wave action. (3) The next phase was one of regular and continuous action; under the influence of the surf on the outstanding parts of the disintegrated mound, a trench was excavated on the line of the former foundation, into which the blocks collapsed. And finally, (4) there set in a prolonged process with cumulative effect; the excavation in front of the breakwater was slowly filled in during the subsidence of the storm.

The port engineer remarks that the structure was universally recognized as one of the most perfect examples of a vertical breakwater and was constantly cited as such. All that experience elsewhere could suggest was embodied in the undertaking. Specially should be noted the intimate connection of the blocks by means of reinforcing ties in the concrete keys, and the exceptionally low level of the foundation course. The work itself had been carefully executed and, prior to the storm, was in an excellent state of maintenance. It resisted throughout the night of Feb. 2-3 the assault of a raging sea that far exceeded all previous experience, and it only succumbed to the onslaught of a surge of more than 9-m. depth, engendering a breaking wave of over 18 m. in crest height, which by its subsequent suction gave rise to the formation of a deep trench in which the wall was ultimately engulfed.

Concluding his remarks on the failure, Mr. Cunningham states that present assumed depths at which wave action will not affect rubble foundation are open for reconsideration. The danger of sand foundation has also to be guarded against.

Mattress and concrete block protect light stone fill

A new outer harbor for the port of Dunkirk, France, is formed by two converging entrance jetties notable in the case of the west jetty, which receives the brunt of the sea attack, for the heavy foundation of rubble fill on brush mattress held down on the crest and ocean slope by 40- to 50-ton concrete blocks. This foundation, as shown by the accompanying cross-section, rises to El. +3 m. above mean low water and carries a vertical wall superstructure of concrete between artificial stone-block walls built up to serve as forms for concrete construction as well as for permanent facing. Only about 1,640 ft. of jetty seaward of the low-water contour has the foundation illustrated. Inshore for about 820 ft. the superstructure rests on mass concrete between parallel lines of steel sheetpiling. At the head of the jetty the water depth at mean low water is about 32 ft., and throughout the jetty length the foundation rises about 7 ft. above water level.

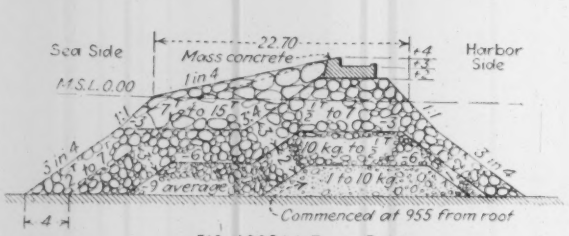
The construction procedure involved no novelties. Brush fascine mattresses were woven in the harbor, floated to position and sunk to the sand bottom by loading them with stone. The rubble fill was dumped from hopper barges. A derrick boat placed the concrete blocks, which were moulded on shore in vibrated forms. The facts for this description are taken from an article in *The Engineer*, March 15, 1935.

Graded stone-fill breakwater at Haifa

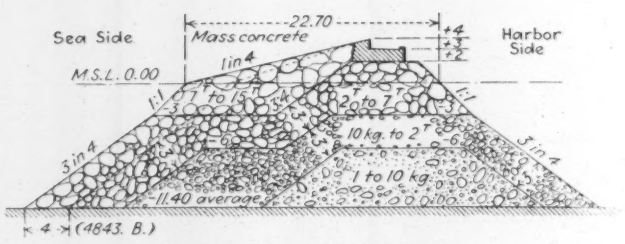
A rock breakwater of interest because its designers undertook by grading to utilize the complete quarry product of large and small breakage has been completed for the new harbor works at Haifa, Palestine. Haifa is on open coast; the harbor is formed by a main breakwater 7,250 ft. long extending offshore at an angle of about 30 deg. and by a lee breakwater 2,510 ft. long, partly closing the sea space between the outer end of the main breakwater and the shore. The outer end of the main breakwater is at contour depth 40. This open-sea barrier takes the brunt of the wave attack.

The following facts are taken from *Engineering*, March 1, 1935, which credits its information to a paper of Jan. 22, 1935, before the Institution of Civil Engineers, by E. J. Buckton of Rendel, Palmer & Tritton, London, consulting engineers for the Haifa harbor works. Studies by the engineers indicated a fine sand bottom. The maximum recorded variation from mean sea level due to combined wind and tide was found to be from +1 to —2 ft. A study of wind records and currents indicated a rockfill structure, but one, which considering the wave magnitudes, prohibited run-of-quarry fill and called for a graded-stone structure. The design adopted is shown by the two cross-sections. The sizing of the stone from foundation to top and as the fill reached out into the sea is to be noted. By this design virtually all the product of the quarry was used while escaping the objections of quarry-run fill.

The rockfill was constructed by a mobile pillar crane that traveled on track on top of the fill as it progressed seaward. Skips on cars brought the stone from the quarry 10 miles inland, and the crane dumped the skips. On its outshore trip the crane placed the fill to El. +2 m., and on the return trip it completed the fill to El. +4 m., placing the large stone by slinging and cleaning up and trimming crest and slopes. It was felt that this two-stage construction would allow the sea to compact and bond the body of the fill before the topping stone and concrete coping were placed. The coping was concreted by a floating plant that followed the crane on its inshore trip.



510-1008 M. From Root

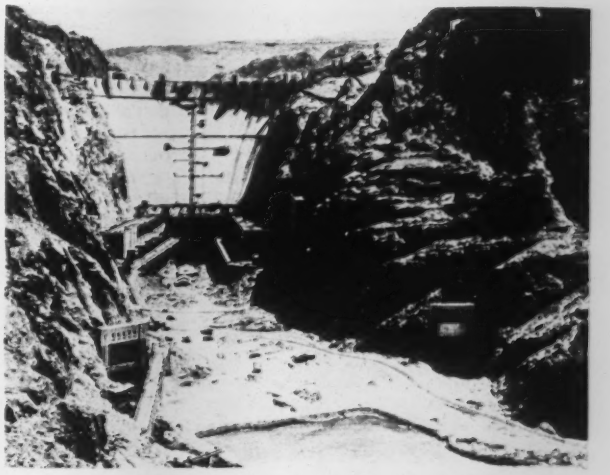


1,008 M. From Root to End

SECTIONS of Haifa breakwater, showing grading of stonefill designed to utilize entire quarry product of large and small breakage.

Notes from the Field—

Boulder Dam and the Los Angeles Region



BOULDER DAM as it appeared two weeks ago with water in the reservoir above the bases of the intake towers and powerhouse construction in full swing in the canyon below the completed dam.

A VISITOR to Boulder Dam today finds the dam in Black Canyon on the Colorado River completed except for minor details, but that does not mean that activities on the Boulder Canyon project are drawing to a close, as he will find if he has the advantage of being guided by one of the engineers and thereby enabled to see many things not apparent to one who gets as far as Lookout Point only. The usual tourist, seeing the dam from the latter point, goes away with the impression that the job is about done.

Even before the dam is reached there is evidence of real work in progress. Swinging down the hill toward the dam from Boulder City the first sight that catches the eye is an array of great steel castings waiting to do down into the canyon, to form the housing for the turbines. And then there appears a sheet of clear green water, the lake forming behind the dam. Already it is over 20 ft. above the sills of the lower gates in the intake towers.

Nearing the dam, one sees lines of bright copper conductors pass overhead, supported by steel towers skillfully set on the few vantage points that the indescribably rugged walls of the canyon provide. They are for parallel circuits that are to carry power at 287,000 volts across 268 miles of desert to Los Angeles. That work is well under way, and bids have been called on the 230-mile lines that will carry power to the pumping stations along the Colorado River aqueduct. Setting the towers on the canyon's edge, to support the conductors as they rise from the transformer station down in the canyon, is one of the electrical problems just now.

In a side valley is the penstock-fabricating plant of Babcock & Wilcox, its yard filled to its limited capacity with great sections of pipe waiting their turn to be towed down the steep road to a point under the big cableway, by which they are lowered into the canyon. Indicative of the change in the stage of construction is the fact that the June payment to Babcock & Wilcox exceeded that made to Six Companies.

Except for the finishing touches, the dam itself appears to be completed. Men are working around the tops of the intake towers preparing for the installation of the gate-operating machinery; the spillway gates and gate-operating equipment are in place, and the upper ends of the spillway tunnels are being cleared of formwork. Rock work for the approach road on the Arizona side has just been completed, but the road has yet to be graded and surfaced.

High on the canyon wall, the concrete-mixing plant, scene of such intense activity for so many months, is taking a well-earned rest. Only a relatively small amount of concrete is required now, and that at irregular intervals.

Going down into the canyon by the road, itself a marvel of mountain highway building, one finds the first center of activity to be work on a new tunnel on the Nevada side that will give access by road to the powerhouse after the contractor has taken away his temporary bridge that spans the stream coming from the outlet tunnel. And the water now passing under the bridge, discharged from the reservoir to meet the requirements of irrigators along the lower river, belies the name Colorado. Instead of being the silt-laden river of history it is a crystal-clear stream of emerald hue. Downstream, I am told, it picks up a new load of silt before it has gone many miles.

The superstructures of the powerhouses are nearing completion. A striking element is the unusually heavy character and close spacing of the roof trusses. They are designed to protect the power generators from possible rock falls and, in combination with the concrete roof slab and a protective blanket of earth, must absorb the live load of a large boulder falling from the top of the canyon wall.

Liner plates for the draft tubes of the initial units are being installed, but little other work on the power equipment is under way, as the interior is wet and dripping with water used to keep the fresh concrete moist.

The canyon floor was not the hot hole that I had anticipated. Evaporation from the wide expanse of powerhouse walls and cool air from within the powerhouses and draft tubes tempered it considerably. However, according to Walker Young, the job at that time was blessed with "summer resort weather" for several days. In Boulder City the temperature was well under 100 instead of up around 110.

Work within the powerhouses soon will be in full swing. The four units of 82,500 kva. for the Los Angeles Bureau of Power & Light are to be installed on the Nevada side; one 40,000-kva. unit will be installed on the Arizona side. There also will be two station service units of 3,000 kva. each. These latter units will be in operation by October of this year, and the first of the large units will be in operation some time before June, 1936.

As soon as these units are well under way it is expected that work will be begun on two of the four similar units for the pumping load of the Metropolitan Water District of Southern California. They also will be on the Nevada side—perhaps to have them beyond the reach of an injunction issued in Arizona.

Within the canyon walls the work of installing the 30-ft. steel penstocks inside the 50-ft. tunnels is going forward actively. Smaller lines, 13 ft. in diameter, lead from the main penstocks through smaller tunnels to the powerhouses, and 102-in. lines lead to the two canyon-wall valve houses through which water will be discharged when the turbines are not meeting downstream demands. The upper lines of 30-ft. penstocks are well along toward completion, and the conduits to the valve houses are being backfilled with concrete.

Concrete plugs have been put in both the diversion tunnels on the Arizona side and in the penstock tunnel on the Nevada side. Part of the plug in the other tunnel on the Nevada side is in place. It contains the valves through which water is being discharged to meet irrigation demands. That plug will be completed when the penstock lines are in operation.

Los Angeles region

Those who travel to the Pacific Coast should not place too much confidence in the "all air-conditioned trains" that are now advertised. The railroads thought they had enough cars to equip the advertised trains, but they did not count on the large increase in passenger business that has taken place this summer. Both the train into Las Vegas and the one out had extra sleepers that were not cooled.

Only a small group of the American Society of Civil Engineers convention party took in the trip to Catalina Island, but those who did were well repaid. Aside from its natural beauties, the island is of interest to the civil engineer because it is an isolated community almost entirely under the control of the Wrigley Estate. S. E. Carpenter, engineer for the Santa Catalina Island Co., has all the municipal engineering problems on his hands and a lot of miscellaneous work in addition, including roads, buildings and a thriving pottery industry. Rainfall is limited both in amount and in distribution throughout the year: hence it has to be carefully conserved for domestic use. Salt water is used for fire protection and flushing. Additional storage is one of the immediate problems.

A small group set out for a two-day trip into San Gabriel Canyon, to see the flood-control dams, and went out onto the Colorado River Aqueduct to see part of that great undertaking.

It is not difficult to understand why large flood-control dams are needed on such streams as the San Gabriel River: the canyon is narrow, and the mountain sides are steep and only sparsely covered with vegetation. The runoff is about like that from a steep roof. Following any unusually heavy rainfall, it sweeps out onto the plain in a great flood wave.

Work is at a standstill on Dam No. 1, a great rockfill structure started many months ago, while the engineers of the Los Angeles Flood Control District, its consulting board and the state's engineers agree on a modified design. What one sees first in the canyon is a high quarry face, below which is a great pile of waste rock containing several million yards of the material discarded in getting the 500,000 cu.yd. of acceptable rock that has gone into the dam. Upstream from the quarry the dam site has been stripped, part of the cutoff wall placed, and the fill built up to about the original streambed level. An outline of the proposed new section with flatter slopes, using the material about as it comes from the quarry, has been marked on the canyon walls. In the valley above, the dam engineers were working overtime to complete data obtained from small sections of fill made from the quarry run.

Dam No. 2 is much farther upstream in one of the side canyons. It is another rockfill. As will be recalled, so much settlement occurred a year and a half ago, about the time that the fill had been completed and before all of the concrete slab on the upstream face had been completed, that the concrete face was stripped off and a flexible timber face was substituted (*ENR*, June 13, 1935, p. 836).

When we visited the dam there was very little water in the reservoir, and work was in progress calking the joints with oakum and asphalt.

Colorado River Aqueduct

Coming down out of San Gabriel Canyon in mid-afternoon, the party turned east, heading for Berdoo Camp far out on the Colorado River Aqueduct near the middle of the 18-mile tunnel at the easterly end of the Coachella group. We reached there about 8:30 p.m. and found a train waiting for us to take us into the heading, some 15,000 ft. east of the Berdoo adit. Of the entire 18 miles there remains but 7,000 ft. to be driven. The tunnel, a 16-ft. horseshoe section, has caused very little trouble. It is dry and no unusual ground conditions were encountered.

In the morning we visited other sections of the Coachella tunnels, to see some of the concrete lining, also to see the work of re-excavating and timbering at a point where the roof of the tunnel had been broken in by the falling of a mass of shattered rock that had been penetrated successfully when the tunnel was driven.

The concrete work has an exceptionally fine finish. Steel forms are used, and concrete is pumped in and vibrated. No attempt is made to form vertical ring joints; the concrete is allowed to take the natural slope; hence all construction joints are in a flat sloping plane. In the tunnels the concrete is sprayed within enclosed areas for curing; at the portals it is sprayed with a bituminous curing compound and then whitewashed, to reduce heat absorption.

It would be hard to find a greater contrast in tunnel construction than is found in going from the Coachella to the San Jacinto tunnels. The Potrero shaft, 800 ft. deep, has been flooded twice, and when we were there the pumps were discharging 5,500 gal. per minute. Both headings are wet, but it is in the last heading that the contractor ran into the worst conditions, when he attempted to drive through a shear zone a few hundred feet from the bottom of the shaft. The District now has taken over the work and is putting an elaborate pumping plant in a watertight chamber near the bottom of the shaft. The pumps there can be entirely controlled from the surface in an emergency. In the first break the rush of water and debris swept to the bottom of the shaft, disabling the skip so quickly that the men had to climb up the ladder 800 ft. to the surface.

The district has abandoned that heading and now is driving a new heading at a point farther south, using pressure-grouting on any hole that brings in a large flow of water—and that means most of the holes. The district's engineers now have the advantage of knowing where the fault is and about how wide, having explored it by advance drilling.

Conduits and siphons

Concrete work on the pressure conduits and cut-and-cover conduits along the aqueduct is done after sundown on account of the heat. Our schedule was arranged to bring us down into the San Jacinto Valley to the Casa Loma siphon in the early evening. The pressure siphon is of circular section, and the conduit is of horseshoe shape, both about 16 ft. in diameter. The siphon is of reinforced concrete and is unusual in that steel diaphragms are put in at frequent intervals to make planes of weakness in the form of a bell-and-spigot joint. This is done to concentrate rupture at predetermined points in case of earthquake movements.

Both conduits and siphons are built with movable steel forms, inside and out. The forms have been specially designed with many doors for easy access to the concrete and with built-in chutes that discharge the concrete at any point up the side of the barrel. The openings greatly facilitate the use of vibrators around the reinforcing in the siphons.

Curing is by a sprayed-on bituminous curing coat covered with whitewash on the outside, and by water spray inside.

The curing sections, shut off by burlap partitions, are not unlike hot Turkish baths.

Los Angeles Union Station

The much talked-of and fought-over Union Station in Los Angeles is actually under construction. Old buildings have been cleared from much of the several acres of ground on which the station, its tracks and plazas are to be built, and many thousands of yards of earth have been placed in a rolled fill upon which the yard track will be laid.

The fill is being built with almost as much care as an earth dam, to minimize settlement. Concrete work on a wide passenger subway through the fill is well along toward completion. It is notable in that it is designed as a rigid frame with deep legs down to a foundation slab on firm bearing material.

One of the old concrete men, seeing the forms for the legs narrower at the bottom than at the top said, "The damn engineers have got those walls upside down!"

Work on the station itself is held up while Uncle Sam makes up his mind about a post-office building that he wants to put on the site. The station was designed as a low structure of Spanish type, but the Post Office Department wants to put up a five- or six-story structure on the large area of station ground assigned to it in laying out the preliminary plans. —V.T.B.

San Francisco, Calif.,
July 12, 1935

Ice-Pressure Determinations in Clay Soils

Crystallization pressure increases approximately in direct proportion to the amount the temperature is below freezing

NEW and interesting results on the pressures exerted by growing ice lenses in freezing clay are given in a paper presented by Arthur Casagrande, of Harvard University, before the Society for the Promotion of Engineering Education at the recent meeting at Atlanta, Ga. These results have come out of an extensive research now being carried on at the Harvard soils-mechanics laboratory.

In this particular determination, freezing tests were conducted on a closed system (Fig. 1), the lower portion of the container being filled with saturated mica powder and the upper portion with Boston blue clay at the liquid limit. The temperature at the bottom of the container was kept at +3.5 deg. C. in all tests, while the temperature above the sample varied between —1.0 and —7.5 deg. C. In the test shown in Fig. 1, a temperature of —2.0 deg. C. was kept until the penetration of the frost line into the sample had ceased. Then the container was removed, the sample sawed in half, the ice formation studied and measured and, finally, numerous small samples were removed for the determination of the distribution of water contents.

The original water content of 42.4 per cent was reduced in the clay between the ice layers to an average of 27.5 per cent, and in the clay beneath the frost line to 29.6 per cent. A large amount of water was also pulled from the mica layer, compressing it more than one-fourth of its volume and decreasing its water content from 75.3 to 41.7 per cent. The total height of the ice layers was about one-third of the height of the frozen portion.

Since the frost line penetrated at a very slow rate, considerable quantities of water could flow toward the growing ice layers from beneath. The faster the freezing was carried out, the smaller was the amount of additional water supplied from beneath. If the rate exceeded a certain limit, the entire water segregated in the form of ice came from the clay between the ice layers, which resulted in a constant water content for the entire frozen portion. The clay between the ice layers was just as plastic as at temperatures above freezing, indicating that at —1.0 to —2.0 deg. C. none of the water in the pores of the clay was frozen.

Consolidation tests (compression in confined state) were carried out on the clay and the mica powder used in these tests for the purpose of determining the pressure required to reduce the water contents to the values obtained in the freezing tests. By correlating the determinations of all tests and plotting pressures against temperatures, the chart shown in Fig. 2 was obtained for the clay, and a similar chart for the mica powder. Since temperatures and water-content determinations showed considerable variations, each result is shown in form of a rectangle, indicating the range in which the actual value must lie.

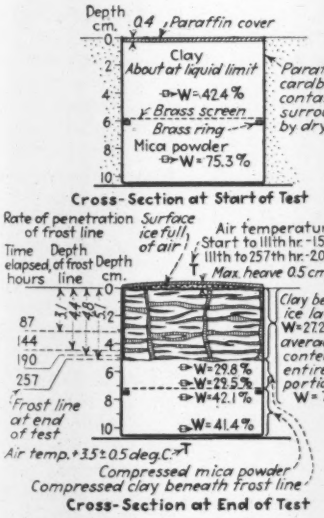


FIG. 1—FREEZING-TEST SKETCHES showing original condition of sample and condition after freezing test had been completed.

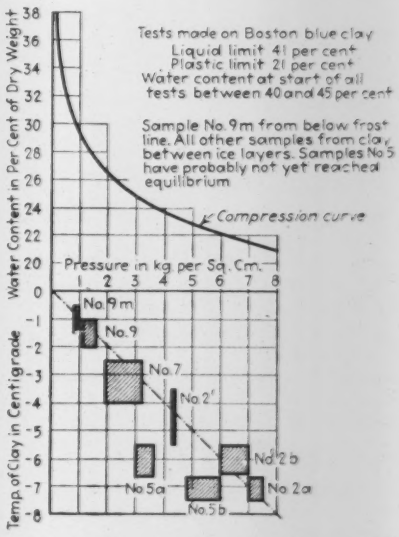

Tests made on Boston blue clay
Liquid limit 41 per cent
Plastic limit 21 per cent
Water content at start of all tests between 40 and 45 per cent
Sample No. 9m from below frost line. All other samples from clay between ice layers. Samples No. 5 have probably not yet reached equilibrium
Compression curve
Pressure in kg. per Sq. Cm.
Water Content in Per Cent of Dry Weight
Temp. of Clay in Centigrade
No. 9m
No. 9
No. 7
No. 2'
No. 2b
No. 2a
No. 5a
No. 5b

FIG. 2—RESULTS of consolidation test of clay to determine pressures required to reduce the water content to the values obtained in the freezing tests.

Conclusions

These tests indicate that the crystallization pressures are not a constant but increase approximately in direct proportion to the amount the temperature is below the freezing point. The values No. 5a and No. 5b were obtained from tests that were terminated after a much shorter period than were the other tests, indicating that probably frost action had not yet reached a state of equilibrium. At present, tests are in progress that will permit a much more accurate determination of the relationship between temperature and pressure of crystallization.

Incidentally, these tests have definitely proved that in true clays having considerable plasticity any amount of ice segregation can be produced, provided the freezing proceeds at a sufficiently slow rate.

Book Reviews and Notes

A Monthly Commentary on Current Additions to the Civil Engineer's Library

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Modern Tenement Technique

REHOUSING URBAN AMERICA—By Henry Wright. Cloth; 9x12 in.; pp. 173. Halftones, line drawings and tables. Published by Columbia University Press, New York City. $7.50.

No such complete manual of good practice for large-scale group housing as this new book has heretofore been available. Mr. Wright, in association with Clarence Stein, developed Radburn, in New Jersey, Sunnyside, in New York City, and Chatham Village, in Pittsburgh. He has been technical advisor to the PWA Housing Division in all of its planning, so that his perspective and experience are wide enough to assure an authoritative character for the book. Briefly, the book presents a digest of the elements of good community planning and housing technique as related to the author's idea of the course which rehabilitation of our cities must take.

Public Works From the Inside

BACK TO WORK—THE STORY OF PWA —By Harold L. Ickes. Cloth; 5x8 in.; pp. 276. Published by The Macmillan Co., New York, N. Y. $2.50.

IN EIGHTY PAGES of the new book by Secretary of the Interior, Oil Administrator and Public Works Administrator Ickes lies a story that will prove absorbingly interesting to everyone who appreciates the importance of the public-works movement in our national economy and particularly in the fight against the effects of the great depression. The first three chapters, comprised within these pages, contain the meat of the work regarded as a historical memoir. And it justly ranks as such, for it is the only inside story yet published of the early days of the PWA.

It gives facts that throw a searching light on the strange genesis of the National Industrial Recovery Act and on the origin of the delays, the red tape, the fettering labor policies and other phases of the fateful campaign that filled the second half of 1933. The light unfortunately goes out at some critical points, and in other places it wavers; yet the book is a source document on public-works equalization that all future historians of the subject must consult.

Readers of the book will of course have in mind some of the important background conditions. One of them is the long and seemingly hopeless battle for the public-works plan that went on for two years preceding, and the bitter enmity to the "squandering" method of bringing about recovery that still prevailed. Another is the diametrically opposed attitude of two groups, on the one hand that comprising the welfare and reform advocates, on the other the constructive recovery group—a clash that has been most apparent in connection with the 1935 program but that also pervaded the Washington activities of 1933.

Notable figures stalk through the pages of the book. There are Moley and Wagner, La Follette and Beck, Johnson and Waite, members of the Cabinet and the Little Cabinet. There are also such organizations as the American Federation of Labor, the Sanitary District and the Duke Endowment. Governor Talmadge of Georgia appears in an astonishing doublecrossing act. The author utilizes graphic description, quotation, epigram, and biting sarcasm in effective style. The reader cannot fail to be interested.

The three opening chapters in substance cover the events of those broiling hot July and August days, two years ago, when the whole country waited in anxious suspense for word that PWA was in action. In the first chapter the author begins his account in medias res, according to approved story-teller fashion; the Board of Public Works is sketched at its first meeting, June 19, 1933. He quickly turns to preceding events, however: the prior collapse of private construction; the advocacy of various public-works programs, real and fictitious, during 1931 and 1932, including that urged by the American Society of Civil Engineers cooperating with the National Trade Recovery Committee; the attempt of the new Secretary of Labor to establish a dictatorship of wage and hour control in the spring of 1933; the hodgepodge mixing (by Moley, Johnson and others) of a code system to regulate industrial competition with a public-works program; and the final enactment of the National Industrial Recovery Act. The story is not everywhere precise, and the author even pictures the Senate in "the agonies of gestation," whatever these may be; but it is quick, gripping and enlightening.

The chapter closes with the preparatory organizing work of the Spalding-Waite group, and then quotes the President's mystery order of June 16, designed to put the whole PWA on the shelf for three weeks but actually responsible for nearly six months' delay and for the desperate CWA undertaking of November. Here the light goes out; the author fails to explain why the Spalding set-up was cast aside, and leaves one to guess as explanation that the President was as indifferent to the 1933 public-works program as he has recently seemed to be to the new program, and anxious only to get the NRA started so that industry might lift itself and labor out of the mire by its bootstraps.

How the Public Works Board evolved its basic policies is told in the second chapter. Stenographic transcripts (or so they appear) of critical discussions in the board are reproduced. Lewis W. Douglas, budget director, here steps forth in the rôle of one seeking to scuttle the act while a member of the board charged with carrying out the act: "We should put on the brakes, deter municipalities, counties and states from borrowing money . . . by increasing the interest rate." Tugwell and Ickes fought this tory view doggedly, but the compromise on 4 per cent interest resulted. A passage of equal interest deals with the vast allocations to federal departments, although—and here the light goes out once more—the political deals for Bonneville, Grand Coulee, et al, are not mentioned, nor are the depredations made on the public-works fund to support routine Washington bureau operations instead of to produce employment and promote recovery.

At the time, Secretary Perkins was fighting for non-federal projects, and Tugwell for federal work—a strange contest. Federal projects won, presumably on the theory that they would get going quicker, a theory born of ignorance and disproved by subsequent fact. The author's sympathies clearly favor non-federal work. Another passage tells, all too sketchily, of the evolution of PWA labor policies, with Miss Perkins in the rôle of spokesman for the American Federation of Labor. Secretary Ickes says, in speaking of the demands of organized labor for special consideration, "It became apparent that the [labor] organizations were not thinking of the great mass of laboring people who might be benefited by a public-works program but merely of the union worker." The author sets forth the three-zone wage-rate system, prime achievement of the labor bosses, as something accomplished against the wishes of labor. Of course, at that time, the NRA had not yet supplied its demonstration of how consistently a labor lobby and a set of feather-brained bureaucrats could abuse the administration's sympathetic labor attitude.

The chapter is full of meat. It winds up a bit prematurely with mention of PWA Circular 1, issued July 31, after six weeks of precious time had been lost and Title IX of the Recovery Act was well on the road to being wrecked. Mr. Ickes' own statement of the purpose of the act is that "PWA was to entice the nation back to a normal status by starting the flow of money through wages and the purchase of materials, and NRA was to provide the machinery for keeping it there"; but the fact is that the President and the deliberative Public Works Board killed this purpose; before the really significant Circular 3 was issued, weeks later, NRA had run away with the show, leaving PWA, which was designed to lead the advance, to limp on behind as idle rearguard.

Chapter III will revive many memories among those who struggled to get PWA projects going. They will remember how impossible it was to get quick action. Therefore, when the author says that "the technique set up by PWA has produced speed as well as safety," he will hardly carry his readers with him.

Most of the other chapters, describing special fields of work, are less important, through good reading.

Miscellaneous Notes on Booklets and Reprints

A REPORT ON SIGNIFICANCE OF TESTS OF CONCRETE and CONCRETE AGGREGATES has been published by the American Society for Testing Materials, Philadelphia, Pa. The comments of some seventeen authorities are contained in the 120 pages of the report. Price, $1.25 per copy, with reduced prices for orders of ten or more.

WIND ACTION on a tall building bent is being studied by means of a 1/24-scale steel model at Ohio State University, proportioned by means of the Spurr method of design. Results were first reported last October before the convention of the American Institute of Steel Construction. This organization has now cooperated with the Engineering Experiment Station of Ohio State University in publishing a second report of studies of the bent, altered by the addition of a tall basement story and by a two-story entrance. Some theoretical studies of setbacks are also included.

SLUMS AND BLIGHTED AREAS IN THE UNITED STATES is the subject of Bulletin No. 1 of the PWA Housing Division. Written by Edith Elmer Wood, well-known authority on housing matters, particularly from the sociological standpoint, the bulletin provides one of the first comprehensive analyses of slum conditions. It is based on surveys and studies made by Dr. Wood for the Housing Division in fifteen cities, and also contains an analysis of housing conditions as shown by the recent real property inventory of the Bureau of Foreign and Domestic Commerce. The book discusses the effect of bad housing on health, morals, safety and general welfare. It makes a case for the elimination of slums by direct governmental action. This general survey is contained in Part 1 of the bulletin. Part 2 is devoted to a detailed description of existing housing conditions in the fifteen largest cities.

EROSION-CONTROL METHODS are described and analyzed in Bulletin 121, Iowa Engineering Experiment Station, Ames, Iowa. The bulletin, written by Quincy C. Ayres, associate professor of agricultural engineering, is entitled "Recommendations for the Control and Reclamation of Gullies." It covers the treatment of small gullies, principles governing the use of check dams, overfall protection, temporary check dams of brush and woven-wire types, semi-permanent check dams of loose rock, log and plank types, and permanent or soil-saving dams of rubble masonry, concrete and earth types. 69 pages. Price not given.

GEODETIC CONTROL in private boundary surveys is the subject of a symposium published in the May, 1935, *Geodetic Letter* of the U. S. Coast and Geodetic Survey, Division of Geodesy, Washington, D. C. Some twenty replies to a questionnaire sent out by the Division of Geodesy are published, relating experiences in utilizing the national triangulation survey to control and perpetuate private boundary surveys, and giving opinions on drafts of tentative legislation that would make the use of the national triangulation nets for the control of property surveys formally legal.

New Books and Revised Editions

[Those desiring copies of the books listed below or mentioned elsewhere in this section should order them from the publishers or from their local booksellers.]

ANNALI IDROLOGICO—1933—Part II. Paper; 10x14 in.; pp. 181. Published by Istituto Poligrafico Dello Stato, Rome, Italy.

REAL PROPERTY INVENTORY OF THE CLEVELAND METROPOLITAN DISTRICT—Report No. 4—By Howard Whipple Green. Cloth; 9x12 in.; pp. 291. Maps, tables, diagrams. Published by Real Property Inventory of Metropolitan Cleveland, Cleveland, Ohio.

ENGINEERING RADIOGRAPHY—By V. E. Pullin, C.B.E. Cloth; 8x11 in.; pp. 136. Photographs, drawings, curves. Published by G. Bell and Sons, Ltd., London, England. Price, 45s.

QUALITÉS DE L'EAU ET MOYENS DE CORRECTION—By Dr. Ed. Imbeaux. Paper; 8x11 in.; pp. 834. Photographs, drawings. Published by Dunod, 92, Rue Bonaparte, Paris, France.

SIPHON SPILLWAYS—By A. H. Naylor. Cloth; 6x9 in.; pp. 83. Photographs, drawings. Published by Longmans, Green & Co., New York, N. Y. $3.40.

A TREATISE ON SURVEYING—Vol. 1—By Reginald E. Middleton and the late Osbert Chadwick. Cloth; 5x8 in.; pp. 398. Tables, drawings. Published by The Engineers Book Shop, New York, N. Y.

Letters to the Editor

Keep the Survey Work Going!

Sir—In the fall of 1932, through the efforts of the American Society of Civil Engineers and the effective and very practical aid of others who contributed office spaec and furniture, an arrangement was made with the U. S. Coast and Geodetic Survey that resulted in the employment of some 30 engineers on its work. These men, who had been particularly hard hit by depression conditions, served from November, 1932, to the end of the following June. The present administration, recognizing the importance of the work that they were doing, put them back to work on Aug. 10, 1933, for the two-year period ended this June, and increased the number to upwards of 100 in this city and some 2,000 through the nation.

This work, admittedly of prime necessity, being the control for the U. S. Geological Survey's topographic maps and the base for all coast charts and airway maps as well as the plane coordinate systems throughout the nation, is being curtailed because funds for its continuance have not been allocated to the survey. This means that some 2,000 or more men, trained by experience which this highly specialized work requires, will be thrown out. The work itself cannot be stopped altogether or for any great length of time; it is obligatory so long as navigation continues or boundaries exist. When it does go on again, as it inevitably will, the absence of this trained personnel will mean a loss of at least three months' time for each new employee while he is becoming accustomed to the accurate, time-saving and highly efficient methods used in the Survey.

So much for the waste involved, which should be the concern of every thoughtful citizen, engineer or otherwise, to say nothing of the delay. But what of the men? Must they be forced upon the dole—for it might just as well be called by its right name?

I write this to ask that you exert whatever influence that the printed word may have to secure the allocation of funds to continue this work and keep these men employed.

ONE OF THEM.

New York City,
July 19, 1935.

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July 25, 1935

Extra! Man Bites Dog

THE Chicago suburb of Evanston furnishes a piece of real news. The City Council on July 15 accepted a bid for preliminary engineering work on a proposed $400 000 street repair and resurfacing program. *It accepted the highest bid.* The Chicago *Tribune* reports:

> "Five firms had entered bids, and that of Kelker was highest, $21,500. There was one for $6,000, one for $16,000, and two for $18,000."

It is no news when city and county fathers engage the cheapest engineering service that they can find; when they engage the highest priced, it is news indeed.

Continue the Surveys

ANYONE who has observed what the emergency survey work of the last two years has accomplished will have no hesitancy in endorsing the plea of a correspondent, on another page of this issue, for continuation of the surveys. This important unemployment relief undertaking has produced fundamental data that will be of value as long as the country exists and develops, and it has put to work thousands of men, most of them engineers. It is undoubtedly the soundest white-collar project of the entire emergency period. Just now the threat is that it will stop by the end of this month, apparently for no better reason than that the WPA authorities do not fully appreciate the value and the emergency nature of the work. If engineers personally acquainted with its results could impart their knowledge to the officials of the Hopkins group, perhaps this lack of sympathy would disappear.

A Beginning of Clarification

THE DECISION OF the Court of Appeals of the Fifth Circuit injects a note of reason into the confusion created by the lower-court decision on the operations of the Tennessee Valley Authority in particular and on government improvement projects in general. Reversing Federal Judge Grubb of the northern district of Alabama, the three judges of the Circuit Court unanimously hold that the development and sale of power in connection with the TVA's work for navigation and national defense is within the scope of the Tennessee Valley Act, and that the power conferred by the act is constitutional. If this interpretation of federal power is upheld, it will go far to clear up a question that has been muddled almost from the time the Muscle Shoals development was begun, back in the war days—the question of what can be done with the Muscle Shoals power. It will also set at rest an issue that supposedly was settled by the U. S. Supreme Court is upholding the Boulder Canyon Act. That famous case involved a number of purposes necessarily conjoined in a single undertaking; and when the highest judicial authority found the act to be lawful, its findings seemed to lay at rest any doubts whether the government has the power to undertake projects expanding in some particular beyond the normal scope of governmental activities. The Grubb decision, however, gave rise to new perplexity: why Boulder Dam or a reclamation project is lawful in the West but a similar improvement is not lawful in the Tennessee Valley. The Circuit Court's finding rests by direct citation on the Boulder Canyon decision and thereby adopts the basic principle of the latter for general application. The conclusion that, while "the United States cannot engage at will in private business," it nevertheless has the power to sell property which it owns, even though in doing so it may enter into competition with others, is clarifying and removes a serious barrier to the prosecution of necessary public works of major character.

Vision and Water Supply

WILLIAM MULHOLLAND rendered service to the city of Los Angeles which will be appraised more highly as time goes on. His devotion to the city, which had its origin over half a century ago, when as a *zanjero* he tended the water ditches, was ended on Monday by his death. Mr. Mulholland foresaw the most important need of a great community in an area of limited water supply, and he succeeded in launching not one, but two, of the world's largest water-supply projects—the Owens Valley and the Colorado River aqueducts. Denied the privilege of attending a technical school as a young man, he acquired by night study a comprehensive grasp of mathematics and the essential principles of engineering design. Then, through a long and active lifetime and by many applications of these principles, he gained experience of rare breadth in constructing engineering works. On his staff in later years were men trained in the best of modern engineering schools, who looked to him for guidance and to whom he was always "the chief" in the fullest sense of the word. A plain and modest man, he liked to speak of himself as "just a product of the soil." The simplicity which characterized his thought and his planning enabled him to deal directly with fundamentals—a trait that marks great men. Failure of the St. Francis Dam, for which he assumed full responsibility, saddened the later years of his life but cannot diminish the credit that accrued from a lifetime of unparalleled service to the community in which he lived. His vision and his courage led in building for the future.

New Structural Forms

EUROPEAN ENGINEERS have always been noted for their many and varied contributions to the field of structures, and recent years have witnessed no letdown in the fertility of the structural mind across the water. Some of the products of this collective mind we have adopted; all have furnished food for stimulating thought and discussion. Two examples are presented in this issue, the Vierendeel or portal-frame truss and the thin-shell concrete dome. The former has enjoyed wide use in bridges in Belgium, where it originated at the turn of the century, and lately has been experiencing a new boom under the impetus of welded fabrication. The thin-shell concrete dome is of more recent origin but has been used rather widely in Germany for over a decade. Both of these structural forms are extremely rare in the United States. No Vierendeel truss bridge has been built, to our knowledge, although notable use is made of concrete trusses of this type in the foundations of the Albany

telephone building. For the most part American engineers do not believe that rectangular truss framing is superior to triangular in either rigidity or economy. The thin-shell concrete dome has received even less of a welcome, the planetarium roof in New York being the first example except for a small cowbarn at the Century of Progress Exposition in Chicago. Its advantages nevertheless are plainly demonstrable, and it may have a bright future before it in American structural practice. The important point is that engineers in this country should let none of these European developments escape their notice. Structural thinking is bound by no nationalistic ties, and world-wide community of interest is one of the strong bulwarks of structural advance.

Nature's Warning

FOR SUDDEN AND COMPLETE COLLAPSE under wave action the Algiers breakwater described in this issue sets a record. Within a few hours a massive bulwark designed with all the knowledge of precedent and all the fine skill of computation of a great marine engineering nation fell before storm attack like a wall of toy blocks. The effect is not adequately described by the terms dislodgment and rupture; for a length of a quarter mile the structure simply disappeared, and the storm waves swept unimpeded into the harbor which had prided itself on its protective works. Only the falling of a Quebec bridge or the bursting of a St. Francis Dam have a place in the list of failures as complete as that of the Mustapha Mole at Algiers. And, as in those earlier cases, the fault here lay in too high respect for accepted standards of safety. Conventional assumptions as to depth of wave action were left unchallenged; but in consequence of the exposure of the site and the declivity of the local sea bed the surge of the waves exceeded all records and scoured out the foundation bed, which had been believed to be safe above all other parts. An obvious lesson is that present assumed depths of wave action may need to be reconsidered. A more significant teaching, however, is that no measure of the forces of nature remains static. The greatest flood, the largest wave, the heaviest rainfall of record is no more than a temporary basis from which to compute the factor of safety with which engineering works must be planned. The engineer's prudent foresight, based on judgment shaped by all past experience, is more important than formula or standard practice.

Questionable Principle

WORKS PROGRESS ADMINISTRATION project lists recently issued include many undertakings that cannot be classed otherwise than as regular city work. They are by no means the added social improvements, the extrabudgetary operations, which were to be the means of providing relief work. This regrettable development indicates the same failure to adhere to fundamental principle that characterized the CWA. It needs no deep study to show that when the government constructs a city's normal improvements by relief labor it puts the city on the dole just as truly as the workers are on the dole. And it is much worse for a city to go on the dole than an individual. The process, moreover, holds out a direct threat to normal recovery, for the work thus transferred to the relief program robs the future market; every job given to a relief-roll man on budgetary construction means one less job for regular wage earners next month or next year. In short, the procedure is not alone financially immoral but it is the worst kind of economics. Only narrow-visioned relief planning could defend it, and even the relief worker is apt to find that it creates new problems larger than those which it seems to solve. If the works program is to make further progress toward a sound and constructive condition, its relief operations must be kept out of the field of normal budgetary work.

The Appalachian Parkway

A THOUSAND-MILE PARKWAY along the high slopes of the Appalachian Mountains is the bold plan of the National Park Service. As outlined in this issue, the plan goes far beyond the building of a thousand miles of mountain road; it provides for the creation of a national park which will form a zone of federal property across most of the Atlantic states from Vermont to Georgia. With a broad belt of right-of-way and wider land easements restricting private use, and traversing a dozen national and state park areas and forest reservations, the work planned takes on the characteristics of a park development rather than those of a highway.

This is quite within the functions and rights of the National Park Service, but the fact should be clearly comprehended that the Appalachian Parkway is not an ordinary highway; it is not a transportation route except in a narrowly limited sense. Neither location, alignment nor surfacing fits it for major transportation service. The road is a pleasure drive, and a costly one. It must be appraised, then, on the basis of this restricted service.

As designed, the road is a means of serving and developing access to impressive and exhilarating mountain-forest surroundings over a long stretch of country. This is an engaging conception. But the question may fairly be asked whether a thousand-mile through route is the quickest way to its realization. Is it, as an undertaking for which the public is committed to pay, designed for the wide use of that public or for the occasional tourist with an ample holiday period and ample funds for a grand tour of the mountains? There are sound reasons for thinking that the luxury driver is better served than the one who has only his Sunday, a lunch basket and a family flivver.

Most of the travel into the mountain forests will not be long-distance touring from the Green Mountains to the Great Smokies, but neighborhood travel from tributary settled valleys to the high and cool places a few score miles into the adjacent mountains. Such service does not need continuity of line for a thousand miles; instead it is better provided by developing access roads to local networks of mountain drives, with less attention to location planned for spiritual uplift through magnificent vistas and with more consideration of the lowly pleasures of the everyday picknicker.

A thousand-mile Appalachian Parkway is splendid to contemplate, but it is well to consider whether as a beginning a less grandiose plan would not be a greater service to recreational travel by a tired people. For example, if half of the mileage of the Shenandoah-Great Smoky Inter-Parkway now under construction merely to connect the two parks were shifted in location to traverse the wilds of each of these national parks, this road and trail would more quickly open up opportunities to gain health, open air and intimacy with nature.

CURRENT NEWS

TVA Sale of Power Declared Legal By Federal Court

A DECISION handed down by the federal Circuit Court of Appeals at New Orleans on July 17, reversed the decision of District Court Judge W. I. Grubb of the Northern Alabama district holding unconstitutional the plans of the TVA to sell surplus power generated by hydro-electric plants on the Tennessee River. The decision of the circuit court, which set aside an injunction prohibiting seventeen Alabama municipalities from purchasing power from the TVA and using PWA funds for the construction of distribution lines, represented the unanimous opinion of judges N. P. Bryan, R. E. Foster and S. H. Sibley.

Sale of power upheld

In the opinion of the court the federal government cannot engage at will in competition with private business, but "it by no means follows that it cannot sell property which it owns, even though in doing so it may enter into competition with other public or private owners of property." It was further held that since the government owns Wilson Dam, which was erected and maintained in the exercise of the war and commerce powers conferred upon Congress by the Constitution, it also lawfully owns the water power generated there, and, according to the Constitution, may dispose of that property as freely as any other property. That right has always been supposed to extend not only to accidentally produced surpluses but also to all the excess or surplus. The court states that "As a practical matter there would be no market for the incidental surplus created in an honest effort to produce only enough electricity to supply strictly governmental requirements; for no user, public or private, of electricity would become a customer unless assurance could be given of a firm and dependable supply." Therefore, the surplus need not go to waste but may be sold, and proceeds applied toward reimbursing the cost of the dam. In the opinion of the court a reasonable relation exists between the production and sale of surplus power and the exercise of the war and commerce powers of Congress.

TVA Act constitutional

Discussing the question of whether the necessary power had been conferred on the TVA the court was of the opinion that the TVA Act of 1933 was unobjectionable from a constitutional standpoint in so far as it undertakes to confer on TVA the power to sell surplus electricity to municipalities as well as utility companies. The court here quoted a decision (Arizona v. California) saying "And the fact that purposes other than navigation (and national defense) also will be served could not invalidate the exercise of the authority conferred, even if those other purposes would not alone have

(Continued on p. 135)

Consulting Board Meets for Discussion of Imperial Dam

Construction problems in connection with the All-American canal were taken under consideration by a consulting board of engineers of the Bureau of Reclamation on July 22.

Two major problems were presented to the board. They were a determination of the design for the Imperial Dam to be built across the Colorado River to divert water into the canal, and the route of the canal in the vicinity of Calexico, Calif. In addition the board planned to consider the amount of installed capacity of power plants along the All-American canal. The major problem in connection with the Imperial Dam is to design the desilting works and plan for the disposition of silt to be taken out of the waters of the river before diverting them into the canal.

The board is made up of Dr. W. F. Durand, consulting engineer of Stanford University, Dr. Charles P. Berkey, consulting geologist of Columbia University, L. C. Hill, consulting engineer of Los Angeles, R. F. Walter, of Denver, chief engineer of the Bureau of Reclamation, J. L. Savage, L. N. McClellan, Carl Vetter and H. R. McBirney, of the Bureau's engineering staff in Denver, and R. B. Williams, construction engineer of the Bureau in charge of the work on the All-American canal.

The board will later give consideration to plans in connection with the modified plan for the foundation of Grand Coulee dam on the Columbia River in Washington.

Army Engineers Plan Surveys of N. Y. Streams

THE GOVERNMENT will do what it can to control soil erosion and floods in an effort to avert further destruction in the recently flooded area of New York and Pennsylvania, according to reports from Washington, but there is little prospect of accomplishing much before the September rains, which are now causing apprehension. President Roosevelt announced that the government will participate in any work of a semi-public character but that it cannot undertake home construction.

Prompt approval is expected for the application filed by the Corps of Engineers for an allotment of $200,000 to be used in developing a plan for preventing recurrence of the recent floods. The survey will embrace eighteen counties in New York and seven in Pennsylvania. It will consist of instrument surveys, mapping, a field check of recent damage and preparation of plans and estimates. The New York counties are: Allegheny, Steuben, Schuyler, Chemung, Seneca, Tompkins, Delaware, Oswego, Madison, Cayuga, Onondaga, Portland, Broome, Tioga, Chenango, Otsego, Yates and Wayne. In Pennsylvania the survey will include Tioga, Bradford, Susquehanna, Wayne, Sullivan, Wyoming and Luzerne counties.

(Continued on p. 134)

President Looks Ahead To Plan For Future Relief Needs

(Washington Correspondence)

LOOKING BEYOND the fiscal year which has just commenced, and the $4,000,000,000 relief works program that likewise is just starting, the administration turned this week to consideration of probabilities that must be reckoned with a year hence. It is clear that the administration no longer regards the present works relief program as the last. Allowances will be made for the continuation of public employment in a budget in which the President planned to inaugurate a reduction in the national debt.

Extent of unemployment discussed

A recent conference with secretaries Morgenthau, Hopkins and Perkins was devoted to a discussion of the best method of getting a line on the extent of unemployment next Dec. 15, or thereabout, when he must prepare his next budget message for Congress.

The President expects that, naturally, there will be some unemployment on that date. What the situation will be when the $4,000,000,000 is spent can only be revealed by the trend of business conditions in the next fifteen months.

PWA makes good showing

In the meantime, announcement of employment created by the works program are misleading, as included in them is the CCC enrollment and other continuing activities. Allotments for PWA works programs in various states are small to date but continuous. PWA is making a surprisingly good showing. Applications from local public bodies, numbering more than 1800, propose construction of public works costing $465,000,000. Many of these projects, on review, undoubtedly will go by the board, but the total already is close to half PWA's volume under its old program, which covered 4042 non-federal projects, costing $1,069,173,057, of which 20 per cent is not yet under construction.

Louisiana has been barred from participation in the new PWA program while the Long-enacted laws, which attempt to subject PWA operations to state supervision, are in effect. Release of funds for 29 pending projects, totaling $8,980,700, including 10 for $3,530,600, actually under construction, also has been suspended.

Important Projects Authorized By Allotment Board

ON July 23 the Works Allotment Board recommended a number of important allotments for both federal and non-federal work including two stream survey undertakings. The total of work authorized by the recommendation is about $80,000,000.

To continue work on Fort Peck Dam $6,000,000 was allotted. Construction of Conchan Dam on the South Canadian River in northeastern New Mexico received $4,500,000. This structure is to be an earth dam 230 ft. high and of nearly 5 miles total length, to store 800,000 acre-feet for flood control, water supply for Tucumcari and some irrigation. Surveys of the flood areas in New York and Pennsylvania and of Willamette River flood control and water utilization in Oregon, to be carried out by the Corps of Engineers, were allotted $200,000 each.

Reclamation projects received $64,830,000, substantially in accordance with the tabulation below. The major items in the list are continuation of the work on the All-American Canal and beginning of construction on the huge Central Valley project in California. The latter includes as the largest piece of initial work the building of Friant Dam on the San Joaquin River to provide a water supply to lands now reverting to desert through failure of groundwater supply. Construction of the Roza unit of the Yakima project is also included.

The sum of $3,198,566 was allotted to the PWA for 24 non-federal projects.

New Reclamation Projects

On July 16 the Advisory Committee on Allotments set aside $100,000,000 for reclamation projects to be carried out under the Bureau of Reclamation. Of this list the following projects, totaling $34,560,000, have already been approved by the President.

State and project	Amount
Montana, Frenchtown	$60,000
Washington, Columbia Basin	
Grand Coulee Dam	23,000,000
Wyoming, Casper-Alcova	10,000,000
Administrative expenses	1,500,000
Total	$34,560,000

The other projects in the list considered at the Allotment Committee meeting of July 23, are the following:

State and Project	Amount Requested
Arizona	
Gila	$2,000,000
Salt River	4,500,000
California	
Central Valley	20,000,000
All-American Canal	15,000,000
California-Oregon	
Klamath	135,000
Colorado	
Grand Valley	200,000
Idaho	
Boise—Payette	1,000,000
Boise—Arrowrock Dam	600,000
Boise—Drainage	160,000
Montana	
Sun River	715,000
Bitter Root	200,000
Buffalo Rapids	1,000,000
Chain of Lake Storage	1,000,000
New Mexico	
Carlsbad	1,500,000
Oregon	
Deschutes	1,000,000
Burnt River	500,000
Owyhee	1,500,000
Vale	340,000
South Dakota	
Belle Fourche	70,000
Utah	
Provo River	3,000,000
Ogden River	500,000
Moon Lake	240,000
Washington	
Economic Investigations	250,000
Yakima—Roza	5,000,000
Yakima—Storage	280,000
Wyoming	
Riverton	1,000,000
Shoshone—Heart Mountain	1,500,000
Other	
Col. River Investigations	250,000
Secondary projects	500,000
Administrative expenses	1,500,000
Total	$65,440,000

In its original resolution of July 16, earmarking $100,000,000 for reclamation projects, the Allotments Committee included the stipulation that the Secretary of Agriculture and the Secretary of the Interior should come to an agreement that unproductive land be retired in an amount equivalent to the new land brought into cultivation by the projects. Such an agreement has since been made, so that immediately upon the President's approval of the Committee's recommendations of July 23 all the projects included in the above list will be ready to go forward.

PWA May Reduce Interest To Facilitate Loans

Administrator Ickes stated on July 23 that PWA's decision to reduce its 4 per cent rate in special cases on recommendation of the committee of which Mayor LaGuardia has been appointed chairman "May have the effect of persuading bankers to be satisfied with a more reasonable rate than they have been demanding."

Chicago Sanitary District has filed supplemental application for about $15,000,000 that PWA now has under consideration. Allotment would be made from old PWA funds, not from new appropriation for relief works.

Laboratory Method for Training Architects

Closer co-ordination between collegiate instruction and field work in architectural engineering will be established this fall at the Massachusetts Institute of Technology, following consultation with leading members of the profession. The work will begin in the first year of architectural schooling and will include the selection and purchase of a suitable lot, making plans and specifications for a moderate-sized residence, the selection of a building contractor and supervision of each step of construction. When completed the residence will be sold and the proceeds used to purchase a new location and finance the erection of another house for the next class. Extended training in problems of real estate, economics, financing, office practice, design and construction will feature the course, including plans, specifications and relations with contractors.

Alabama Cities Get Funds for TVA Power Lines

Funds for the construction of municipal systems to distribute electric power from the TVA will be made available at once to the cities of Florence, Tuscumbia and Sheffield, Ala., according to a recent announcement by the PWA. As a result of the recent decision by the Fifth Circuit Court of Appeals in New Orleans that the government could sell power in competition with private companies the three cities will receive an aggregate of $796,000 to construct plants and transmission lines. It is expected that the favorable decision will lead to loans and grants to other municipalities in the near future.

MODERN MASS HOUSING AS ENGLAND DOES IT

Although the British Government has provided legislative help and subsidy for slum clearance housing, by far the greater proportion of housing built during the past decade has been of the type illustrated. This is a new satellite village near Kingston outside of London. Planned communities on new land have proved to be much less costly than slum clearance housing, and they also permit each resident to have a lawn and garden. Much of this housing is built by local authorities and so-called public utility companies aided by government subsidy and land-use laws.

Army Flood Survey

(Continued from p. 132)

The Senate approved the Wagner bill extending the availability of a $3,500,000 Reconstruction Finance Corp. loan through 1935 and 1936. The bill is designed primarily to extend aid to the New York flood areas.

Already WPA allotments of $88,000 for flood rehabilitation have been approved and additional applications from many cities and counties have been sent to Washington.

Stream flow greatest on record

Stream flows, approaching a volume almost four times greater than any previously recorded, following the recent rainfall which exceeded 7½ in. in 24 hours, are revealed in the compilation of run-off records and precipitation data in the New York flood zone. These records and a map of the principal drainage areas affected will be published in next week's issue.

Government Appeals Demurrer Filed in Willacy Case

An appeal has been taken by the government to the District of Columbia Court of Appeals from the district supreme court's decision sustaining a demurrer to an indictment, by a special grand jury last March, of Maj. Charles R. Olberg and Perry A. Welty, former PWA engineers, on charges of conspiracy to defraud the government in connection with an application by Willacy County (Tex.) Water Control District No. 1 for combined loan and grant of $4,853,000.

The Willacy district also has been notified by Administrator Ickes that PWA will take no action on its application unless the personnel of its board of directors is changed. He expressed the opinion that such a change would be beneficial to the public service, but at the same time admitted that not all of the officials whose removal he has suggested had been indicted with Olberg.

SOCIETY CALENDAR

PUBLIC WORKS ENGINEERING CONFERENCE, joint meeting of the American Society of Municipal Engineers and International Association of Public Works Officials, Cincinnati, Ohio, October 14-16.

INSTITUTE of TRAFFIC ENGINEERS, sixth annual meeting at Louisville, Ky., October 15-16.

AMERICAN ASSOCIATION OF STATE HIGHWAY OFFICIALS, annual convention, Miami, Fla., December 9-12.

AMERICAN WATER WORKS ASSOCIATION, Central States Division, Pittsburgh, Pa., August 22-24.

NEW ENGLAND WATER WORKS ASSOCIATION, fall convention, Providence, R. I., Sept. 17-20.

Hotchkiss Becomes President of Rensselaer Institute

Dr. William Otis Hotchkiss, former president of Michigan College of Mining and Technology, has been elected president of Rensselaer Polytechnic Institute, to succeed the late Dr. Palmer Chamberlain Ricketts, who died last December. Dr. Hotchkiss will take up his new duties in September.

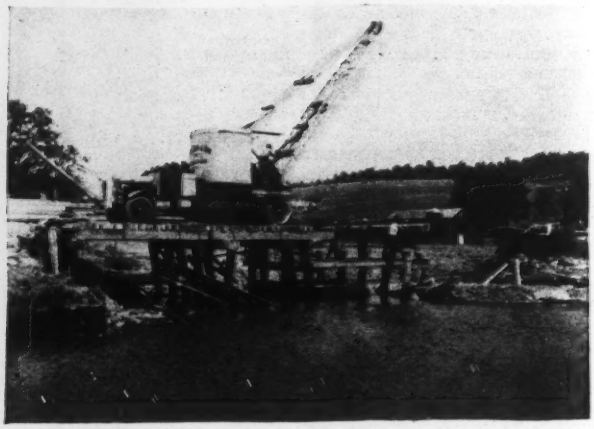
Dr. Hotchkiss, who has been president of the Michigan College of Mining and Technology for the past ten years, has had a long and varied career as an engineer and geologist. After graduating from the engineering college of the University of Wisconsin, he served as an instructor in geology there from 1904 to 1907. He later became director of the state geological survey. He earned his civil engineer degree and his doctor of philosophy degree from the University of Wisconsin in 1908 and 1916, respectively. An honorary degree of doctor of science was conferred on him in 1929 by Lafayette College.

Dr. Hotchkiss was one of the organizers of the Mississippi Valley Highway Association, and he has also done much important consulting work in the iron mines of the Adirondacks and Lake Superior district. After serving on the advisory committee for making plans for the Century of Progress Exposition for the National Research Council, he prepared "The Story of a Billion Years" as his contribution to a non-technical series on the advancement of science.

BRIDGE SCENES AFTER NEW YORK FLOODS HAD RECEDED

ABUTMENT UNDERMINED and settled, approach washed away, this new plate girder bridge over Genegonslet Creek north of Greene requires extensive repairs.

SLAB AND FILL fared badly but new truss bridge at Smithville Flats withstood the debris-lader water.



TEMPORARY CROSSING being built to replace steel girder bridge north of Greene.

Washington Highlights

By Paul Wooton

While President Roosevelt is insisting upon his own tax program, Congress seems to favor a tax on excess profits rather than a graduated corporate income tax suggested by the President. There is an increased disposition on Capitol Hill to think of recovery before reform. This is interpreted to mean a general broadening of the tax base so as to increase the yield materially.

The trade agreement with the Soviet Union makes clear the fact that Russia still is unable to produce enough heavy goods for its own requirements. It emphasizes also that the experiment there is not proceeding as well as was hoped by its sponsors, and is nothing like as bad as enemies of the system predicted. It also is being pointed out that there has been important departures from Communism toward state capitalism.

Nearly every week there is additional evidence that the President is aiming at a constitutional amendment to permit federal control of production. At the same time he favors an increase in the authority of municipal and county officials over local matters. This is diametrically opposite to the Huey Long policy of concentrating most local functions in the state government.

Return to the gold standard is regarded as remote. Supporters of the banking bill argue that with the prospect of a managed currency for a long time to come there must be a national authority with power to control it.

Pending legislation does not deal with the banking structure. No attempt is made to establish such changes as a unified banking system, stricter banking supervision, or branch banking.

Washington, July 22, 1935

TVA Power Sale

(Continued from p. 132)

justified an exercise of Congressional power." It was held that TVA in its operations at Wilson Dam was not doing any more than was authorized by the Act, and that this being so, its motives were immaterial.

The criticism that Congress had abandoned its navigation and national defense purposes was pushed aside by the statement that navigation is now being improved and that the right is reserved to use the property exclusively for national defense.

In commenting on the contention that legislative power was being delegated because there was no recommendation in the document specifying high-type dams or their location, the court declared that the Act provided for the location of Norris Dam but held that a question of the type of the dam was immaterial inasmuch as the question hinges on the sale of surplus power and "Wilson Dam alone, without any assistance from Norris, Wheeler or Pickwick Dams, has a surplus, after serving the transmission lines which it [TVA] agreed to purchase from the Alabama Power Co."

Engineering Surveys Included In New York City WPA Projects

An extensive series of surveys, including the engineering feasibility of a vehicle tunnel from the Battery to Hamilton Ave., Brooklyn, is covered by an allotment of $20,642,000 for New York City's white-collar relief program, approved by President Roosevelt. For the tunnel survey $41,070 is allowed. Another survey, for which $41,070 is set aside, will cover property and population on Second Avenue from Coenties Slip to 180th St., in connection with consideration of a subway route in this territory. The New York City Housing Authority is allotted $2,109,000 for a slum survey.

Various traffic and transit surveys include:

Tabulation and analysis of Port of New York Authority data on ferries, bridges, highways and tunnels, $62,160.

A study of vehicular traffic on various bridges, $24,420.

Bringing up to date old charts of the Transit Commission of passenger traffic counts on all transit systems, $65,490.

A study of the effect of buses on traffic, $27,750.

Engineering surveys

Other features of the program include preparation of a rock line map showing location, extent, character and depth of subsurface rock in New York City, $130,200; and a survey to coordinate various triangulation systems in Greater New York and to extend present net-work in New Lots District of Brooklyn, $63,270. Also included is a survey of the street system of Manhattan to determine with a high degree of precision, street lines and boundaries of blocks, referring each point to the established coordinate system of the city and plotting of an accurate map, $300,810, as well as a topographical survey of borough of Queens, $87,690. A survey of the character of construction materials, covering the design and testing of various as yet undeveloped machines for testing materials, will be done with an allotment of $28,860. For completion of vertical and horizontal survey in metropolitan area, $224,220 has been allotted, and a field check of unnecessary wastings of water in Bronx will be done with $123,900 to the Department of Water supply.

Other WPA projects

Among other projects for which funds have been allotted in construction of the East River Drive extending from Grand St. to 14th St. in Manhattan, for which an allotment of $413,031 has been made. New roadways on the Williamsburg and Queensboro bridges have been allotted $481,000 and $326,000, respectively. For repairs and completion of buildings, $1,854,637 has been allotted. For modernizing the waterfront along the Hudson River from West 23d St. to West 34th St., in Manhattan, an allotment of $751,044 has been made, and for repairs to waterfront structures between West 70th St. and West 72d St. on the Hudson River, $115,424 has been allotted.

A project involving 10 miles of sewer construction, consisting of the reconstruction of 6 miles of dilapidated old sewers and the construction of 2 miles of sanitary interceptors, and including the building of barrel sewer outlets, has been awarded an allotment of $3,154,800. For the completion of Floyd Bennett Field airport a sum of $1,625,507 was allotted.

For eighteen PWA projects in New York City an allotment of $44,553,060 was made, of which $300,000 was to New York University for the construction of a power plant and educational building. The city itself was the applicant on the other seventeen projects. The largest project on the list is the Ward's Island sewage plant for which $25,245,000 has been allocated. A previous allotment of over $11,000,000 was made for this project. Of the rest of the allotment $12,736,800 is for schools and colleges, $5,538,950 for hospitals, borough offices, $704,060, reformatories, $48,200.

New Jersey Members Appointed to Tri-State Sanitation Committee

Five men who will represent New Jersey on the Tri-State Anti-Pollution Commission were sworn into office on July 16. Gerald W. Knight, one of the original survey committee of New Jersey, was elected secretary of the commission. Other members are J. Lester Eisner, William C. Cope, J. Spencer Smith, and Joseph N. Fowler.

Completion of the tri-state commission cannot be accomplished for some time as New York, which passed the interstate agreement in its original form, has yet to ratify amendments made to the agreement by New Jersey. Connecticut has not yet acted upon the plan and probably will not for two years unless its legislature is called into extraordinary session. Connecticut, however, has given blanket authority to the state water commission to represent the state pending ratification of the agreement. Federal approval of the compact is considered to be certain.

The commission will hold its first meeting in New York City on Aug. 15.

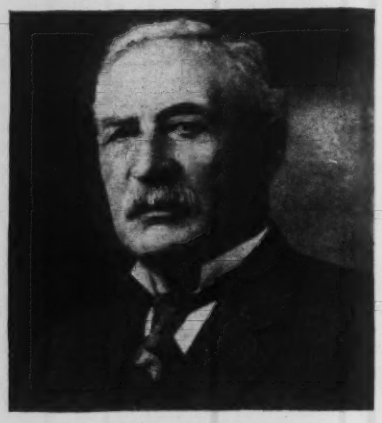
Standards for Hydrologic Data Being Studied by Committee

Under the auspices of the National Resources Board a committee of engineers from the government service and from civil life is studying the subject of standards and specifications for hydrologic data. Its function is to bring about uniformity in the procedure of observing and reporting so that records may be consistent and comparable and results of greater precision. The committee is headed by Prof. Thorndike Saville, associate dean of the College of Engineering, New York University, New York City. Government members are: Capt. J. P. Dean, Corps of Engineers, New Orleans; Willis R. Gregg, chief of the Weather Bureau, Washington; N. C. Grover, chief of the water resources branch, U. S. Geological Survey, Washington; and Montrose Hayes, chief of the river and flood division, Weather Bureau, Washington. Other members are: Donald M. Baker, consulting engineer and chairman of the committee on meteorological data of the American Society of Civil Engineers, Los Angeles; H. K. Barrows, Professor of Civil Engineering, Massachusetts Institute of Technology, Boston; W. W. Horner, consulting engineer, St. Louis; Joseph Jacobs, consulting engineer, Seattle; and Royce J. Tipton, consulting engineer, Denver.

William Mulholland, Los Angeles Water Supply Engineer, Dies

William Mulholland, former chief engineer of the Los Angeles department of water, and widely known as builder of the Owens Valley aqueduct, died at his home in Los Angeles, July 22, at the age of 79.

Mr. Mulholland, whose brilliant career as an engineer was marred only by the



William Mulholland

unfortunate failure of the St. Francis dam, was born in Ireland. In 1872 he came to the United States and spent six years working on docks and steamers in the Great Lakes and on the Colorado River, as well as prospecting for gold in Arizona. He settled in Los Angeles in 1878, obtaining employment with the city water company as a ditch tender. During his spare time Mr. Mulholland read all the books he could obtain on mathematics, civil engineering and hydraulics. As a result of his studies he was promoted from one position to another until he was made general superintendent in 1886. In 1902 when the city of Los Angeles terminated the lease with the water company and took over the task of supplying its own water, Mr. Mulholland was appointed chief engineer of the municipal water system.

When a rapid increase in the population of Los Angeles made an additional water supply necessary, Mr. Mulholland set out for the Owens River country to determine the feasibility of obtaining water from that region. He made the 500-mile round trip in about 40 days, taking observations along the 250-mile stretch, which convinced him that an aqueduct from a point near Owens Lake to the city was practical. He then convinced the city that the aqueduct could be built for a cost of about $24,000,000, and in 1908 the work was started. Finished five years later it assured an adequate water supply for a population of 2,000,000.

In 1923, under Mr. Mulholland's direction, five alternative routes for an aqueduct from the Colorado River to Los Angeles were studied. When the Metropolitan Water District was organized in 1928 the data acquired by Mr. Mulholland was utilized in planning the Colorado River aqueduct now under construction.

After 50 years of service, Mr. Mulholland, in December, 1928, tendered his resignation, which was accepted with the provision that Mr. Mulholland would continue to serve as a consultant for the city, which he did up until the time of his death.

Brief News

BIDS FOR THE FURNISHING of reinforcing steel for use on the Colorado River Aqueduct will be received on Aug. 19 by the Metropolitan Water District of Southern California, at Los Angeles. The schedules call for about 210,000 tons of various grades and shapes of steel to be delivered at various dates during the next three years.

A PLAN FOR DOCK IMPROVEMENT at Glasgow, Scotland, to cost about $34,000,000, was proposed on July 2, by the Clyde Navigation Trust, which has about 270 acres of land available for the project. The plan calls for improvement of 1½ mi. of river, including the widening of the river by about 200 ft. and the construction of docks and piers.

BIDS OPENED AT CASPER, WYO., for construction of the Seminoe Dam and power plant which is part of the Casper-Alcova reclamation project of the U. S. Bureau of Reclamation ranged from a low of $2,194,007, submitted by Winston Bros. Co., Minneapolis, Minn., to a high bid of $2,665,285. There were four bidders on the project.

A low bid of $1,482,651.10 was submitted last week on the Alcova Dam by W. E. Callahan, Dallas, Tex., in combination with Gunther & Shirley of Los Angeles.

Personals

J. E. MORELAND, former design engineer for the Tennessee state highway department, has accepted a position as assistant director of purchases for the TVA.

A. L. PAULS has resigned his position as coordinating engineer for the Muskingum conservancy district to become engineer in charge of construction of the Pickwick Landing Dam for the TVA.

JOHN R. CARROLL, Pittsfield; HERBERT WOODGER, Lenox, and A. B. WRIGHT, North Adams, Mass., have been appointed as staff engineers to inspect dams in Berkshire County, Mass.

A. H. AYERS, chief engineer for Six Companies, Inc., at Boulder Dam since 1931, has been transferred to the Oakland, Calif., office as chief engineer and secretary to the exceutive committee of the company.

COL. WARREN T. HANNUM, who recently completed his tour of duty as division engineer at New Orleans, has arrived in Washington to take up his new duties as chief of the military division in the office of the Corps of Engineers. He succeeds COL. F. B. WILBY, who has entered upon his duties as division engineer at New Orleans.

MAJ. PAUL S. REINECKE, who served several years as secretary of the Mississippi River Commission, is leaving Ft. Humphries to become district engineer at St. Louis. He will be in charge of work on the Mississippi River between Cairo and Clarksville, Mo., and on the Missouri River below Herman.

T. M. BERG has been appointed city engineer of Aurora, Ill., succeeding Walter E. Dieuchler. For the past twelve years Mr. Berg has been assistant city engineer, prior to which he spent nine years in the service of the Wisconsin highway commission.

CHARLES L. KADES, of PWA's legal staff, has been appointed assistant director of the legal division, succeeding John Pershing, of Denver, who has resigned to return to private practice.

FREDERICK A. DELANO and CLARENCE PHELPS DODGE have been named by President Roosevelt as members of the commission for constructing a Lincoln Memorial Boulevard from the Lincoln Memorial in Washington to the Gettysburg Battlefield in Pennsylvania.

HERBERT H. SCHROTH, civil engineer, who was chairman of the committee of the Cincinnatus Association that made a study of river pollution, has been appointed a member of the Cincinnati port authority which will attempt to interest other cities in stopping pollution of the Ohio River.

M. J. MATTHEWS, Paris, Tex., has been appointed as Lamar County engineer to assist in planning projects under the new relief works program.

CAPT. BERNARD SMITH has recently been added to the staff of Maj. E. C. Perry, district engineer at Nashville, Tenn.

HAROLD D. KING has been appointed Commissioner of Lighthouses of the Department of Commerce, succeeding George R. Putnam. Mr. King has been with the Department of Commerce for about 33 years, starting in the Coast and Geodetic Survey in 1903. He transferred from the Coast Survey to the Lighthouse Service in 1911. During recent years he has served as Deputy Commissioner of Lighthouses under Mr. Putnam. Mr. King is both a civil engineer and a master mariner. He received his civil engineering degree from Dartmouth College in 1905. He was superintendent of the Baltimore, Md., Lighthouse District for about 15 years and was appointed Deputy Commissioner of Lighthouses in 1930.

Obituary

CHARLES E. PIERCE, former superintendent of highways for the town of Hopedale, Mass., died at his home there, July 19. He was 90 years old.

JOHN M. CAPRON, aged 55, a former civil engineer on the staff of the New York, New Haven & Hartford R. R., died at his home in Mt. Vernon, O., on July 15.

MORRIS E. HANSFORD, engineer and member of the staff of the West Virginia state road commission, died at his home in Huntington, July 17. He had been on the state road commission staff since 1921. He was 69 years of age.

WILLIAM E. IRISH, member of the contracting firm of the W. E. Irish Construction Co., Syracuse, N. Y., was killed in an automobile accident at Piseco, N. Y., July 16.

JOHN SIMEON ARMSTRONG, civil engineer, died recently at his home in Fredericton, N. B. He was born in St. John,

N. B., 88 years ago, and received his education at King's College, Windsor, N. S.

CHAUNCEY HEAD, 33, civil engineer of Seattle, Wash., was killed on July 11 when he fell from a truck while inspecting work on the Kettle Falls highway.

WILLIAM FAGGEN, designer of jetties for shore protection at several Long Island points, died recently at his home in Far Rockaway, L. I., after a prolonged illness. Mr. Faggen, who was 44 years old, graduated from New York University and Columbia.

F. W. ERICKSON, president of the Erickson Engineering Co., New York City, died at his home in Larchmont, N. Y., on July 16 at the age of 63. Mr. Erickson, who was a native of Denmark, received his engineering degree from Massachusetts Institute of Technology.

FRANK C. HINCKLEY, 61, prominent in engineering explorations and mapping in Maine and Canada, and active in national park development in the Moosehead Lake district, died at his home in Bangor, Me., on July 18. He was a member of the first U. S. geological expedition to Alaska in 1898.

WILLIAM S. RENDLE, for many years an engineer on bridge and building foundation construction along the Atlantic Coast, died at his home in Melrose, Mass., on July 16. He was 72 years of age and until his retirement two years ago was president of the Roy B. Rendle Corp., East Boston, Mass.

OTTO L. DRAPER, 37, surveyor for the U. S. Department of the Interior, in charge of a crew surveying the Alsea River, 20 miles below Alsea, Ore., was killed in a fall on July 10. Mr. Draper, who was born in Rockville, Utah, received his engineering education at Brigham Young University and the University of Utah.

CONSTRUCTION STATISTICS OF THE WEEK

ENGINEERING CONSTRUCTION awards for this week are $25,924,000, an increase over last week of 10 per cent. Of this amount, $5,596,000 represents private contracts and $20,328,000 public work. Of the public work, $6,262,000 is federal and $14,066,000 state and municipal construction. Corresponding totals for the same week last year are: total $29,481,000; private, $3,481,000; public, $26,000,000; federal $3,077,000, and state and municipal, $22,923,000.

The heaviest awards this week are in the earthwork, irrigation and drainage classification, which almost doubled last week's volume, $9,135,000 compared to $4,937,000. Street and road awards are higher than last week at $4,818,000 but do not yet reflect the work that will go ahead under the new funds. Awards in other classifications include: Bridges, $1,100,000; waterworks, $266,000; sewerage, $1,905,000; public buildings, $1,408,000; commercial buildings, $1,983,000 and industrial buildings, $2,893,000.

The larger awards for the week include: preliminary work on produce market and warehouse, Cambridge, Mass., $1,000,000; state highway awards by New York, $617,000; storm water sewers in E. 14th St., Brooklyn, $530,000; Missouri River improvements, dikes and revetments, $731,000, $558,000, $1,101,000, $869,000 and $1,680,000; railroad relocation in Ohio, $592,000, $416,000 and $1,648,000 in connection with Beach City, Wills Creek and Dover Dams respectively. At San Antonio, Tex., the federal government let contract for an underground gasoline and oil storage plant. Rochester, N. Y., authorized construction of an airplane hangar by day labor, $500,000.

New capital for the week includes an increase in non-federal allotments outstanding from the old PWA fund of $1,031,000 and federal allotments from the old fund of $403,000. From the new fund federal allotments approved by the President total $3,718,000 and WPA allotments $13,063,000 (one-fourth of total entered as new capital for construction purposes.) Another $281,000 is added which represents one-fourth the total which is reported as subscribed by local sponsors of WPA projects.

Corporate issues for the week include $125,000 for construction purposes. Much greater activity is noticeable in corporate financing but the majority is for refunding purposes. State and municipal bond sales for the week total $44,204,000. This includes the New York City financing which netted $38,000,000.

CONTRACTS
(Thousands of Dollars)

	Weekly Average July 1934	Prev. 4 Weeks	Week July 25 1935
Federal Government	$10,224	$4,552	$6,262
State and municipal	14,816	11,691	14,066
Total public	$25,040	$16,243	$20,328
Total private	4,450	6,950	5,596
Week's total	$29,490	$23,193	$25,924

Cumulative to date:
1934...$830,974,000 1935...$744,144,000

NEW PRODUCTIVE CAPITAL
(Thousands of Dollars)

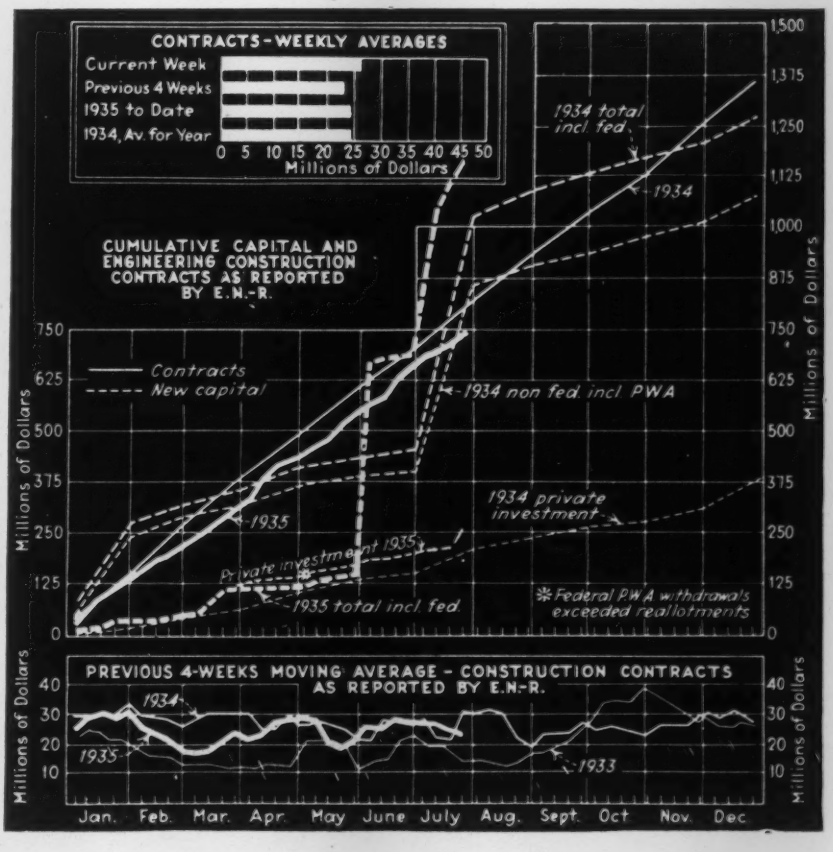
1935	Week July 25	Cumulative
State and municipal	$43,204	$251,341
PWA allotments, S&M	1,031	186,372
RFC loans, S&M	.....	36,084
Corporate issues	125	18,124
PWA allotments, private	.....	8,629
Local contrib. to WPA	281	281
Total, non-Federal	$44,641	$500,831
PWA allotments, Federal Constr.	17,184	669,008
Total new capital	$61,825	$1,169,839

Cumulative to date:
1934..$1,046,941,000 1935..$1,169,839,000

Note: These figures include private bonds, and stocks sold for productive purposes; state and municipal bonds for construction; PWA loans and grants to states and municipalities, including the special highway funds; PWA private loans, and allotments for Federal construction. An arbitrary percentage (25%) of the WPA allotments and local contributions to WPA work is included to allow for the capital additions through the Works Progress Administration division of the new program.

INDEX NUMBER

E.N.R.-Cost	1913 = 100	1926 = 100	E.N.R.-Volume	1913 = 100	1926 = 100
July, 1935	**195.18**	**93.82**	**June, 1935**	**122**	**54**
June, 1935	194.78	93.63	May, 1935	109	48
July, 1934	199.65	95.97	June, 1934	119	50
1934 (Av.)	198.10	95.23	1934 (Av.)	114	50
1933 (Av.)	170.18	81.80	1933 (Av.)	102	47
1932 (Av.)	156.97	75.45	1932 (Av.)	127	56


CONTRACTS-WEEKLY AVERAGES
Current Week
Previous 4 Weeks
1935 to Date
1934, Av. for Year
0 5 10 15 20 25 30 35 40 45 50
Millions of Dollars
CUMULATIVE CAPITAL AND ENGINEERING CONSTRUCTION CONTRACTS AS REPORTED BY E.N.-R.
Contracts
New capital
1934 total incl. fed.
1934
1934 non fed. incl. PWA
1934 private investment
1935
Private investment 1935
1935 total incl fed
*Federal P.W.A. withdrawals exceeded reallotments
Millions of Dollars
PREVIOUS 4-WEEKS MOVING AVERAGE - CONSTRUCTION CONTRACTS AS REPORTED BY E.N.-R.
1934
1935
1933
Jan. Feb. Mar. Apr. May June July Aug. Sept. Oct. Nov. Dec.

Construction Equipment and Materials

Truck Crane Mounting Allows Use of Light-Weight Truck

The Universal Crane Co. of Lorain, Ohio, announces a Ford V-8 truck mounting for their Lorain 30 truck crane. Previously, this crane turntable had been mounted only on trucks of 5-ton or heavier capacity, but the unit has now been made available for mounting on a Ford V-8 truck without loss of rated capacity.

The truck is a standard Ford V-8 truck in all particulars except that an auxiliary axle of any standard make must be added. The crane turntable is a standard Lorain 30 turntable, full revolving, gasoline powered unit, equipped with a 25 ft. boom. With outriggers set, it has a lifting capacity at 10-ft. radius of 13,050 lbs. Without outriggers set, its lifting capacity over the back at 10-ft. radius is over 4 tons.

In order to preserve the all-weather cab on the truck, and yet develop low traveling clearances, a special 25-ft. boom has been developed. This boom has a hinge connection at the center so the top section can be lowered. The truck is equipped with specially designed stabilizing jacks and stirrups which transfer crane loads directly into the two rear axles for crane operation, and eliminate all spring action, thus giving a rigid rear end.

Walking Dragline Features Low Bearing Pressure

Added to the Bucyrus-Monighan group of walking draglines, sold by the Bucyrus-Erie Co., South Milwaukee, Wis., is the new 5-W, a machine, having easy-to-ship features, and having a bearing pressure lower than that of most draglines of its capacity.

The center section of this machine's revolving frame, with all principal machinery assembled in place, is shipped in one unit on one car. This permits easier shipment from the factory, as well as from job to job. Swing mechanisms and fuel oil tanks are below the deck, and the machine is so balanced that little dead counterweight is required. This elimination of excess weight, together with that achieved by electrically welded construction, reduces the ground bearing pressure to 4½ lb. to the sq.in.

Sensitive controls permit rapid operation with little exertion on the part of the operator. As with all other Bucyrus-Monighan walking draglines, direction of travel of the 5-W is governed by simply pointing the boom. The machine travels in a straight line and because it can instantly step off in any direction it can excavate cuts wider than its boom length, depositing spoil to one side only.

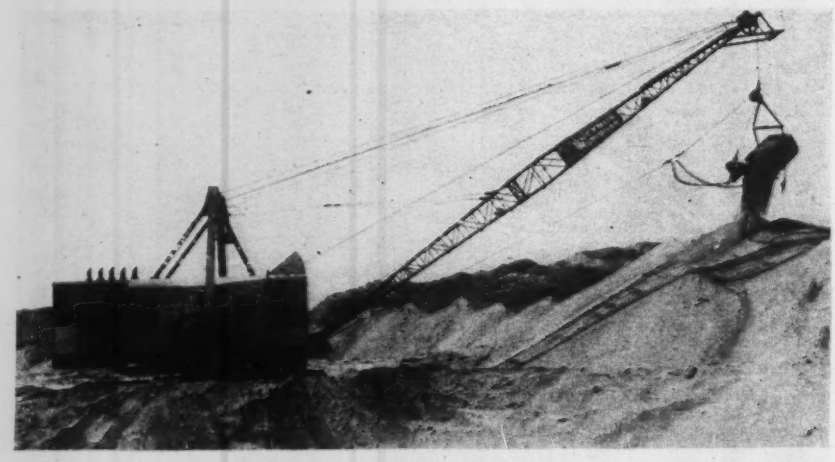
While digging, the machine rests on its large circular base reducing wear and tear on the traction surfaces, because no moving parts touch the ground.

Transportability Features Galion Patch Roller

A patch roller, suitable for compacting all types of loose materials, and having an added feature of portability is being marketed by the Galion Iron Works & Manufacturing Co., Galion, Ohio. The roller is equipped with a hand operated hydraulic pump and double acting ram which lifts the compression roll of the ground about 9 in. A towing tongue, designed to hook on the cross-member of a truck chassis, allows the compression roll to be raised so that the roller may be towed easily.

The total weight of the patch roller is 6,300 lb. of which 5,000 lb. is on the compression roll. Weight on the roll may be increased to 7,300 lb. by filling it with water. When being towed more than half the weight of the roller is on the rear wheels. The compression rolls is 42 in. wide and has a diameter of 48 in.

Close to curb rolling is made easy by a flexible steering axle which allows one wheel to ride on top of the curb. The portable patch roller is powered by a four cylinder, 11 hp. gasoline engine.



Bucyrus-Monighan Walking Dragline

New Equipment in Brief

Interchangeable Breaker and Sheeting Driver. A breaker for demolition work, the Worthington No. 10 Master Breaker, which is convertible into a sheet piling driver is a recent development of the Worthington Pump and Machinery Corp., Harrison, N. J. Fatigue-creating recoil is eliminated. Conversion to a sheeting driver tool is quickly performed. Either the breaker or the sheeting driver may be purchased as a separate unit. The weight of the breaker is 82 lb.; length over all without tools, 29 in. The weight of the sheeting driver is 120 lb; length over all 28¾ in. The standard head is for 2 in. sheeting but, when specified, heads are furnished for 2½ in. and 3 in. sheeting.

New Publications

FAIRBANKS VALVES, The Fairbanks Co., New York City. 6x9, 52 pages. Catalog No. 21.

INFORMATION HELPFUL IN SPECIFYING WIRE ROPE, Macwhyte Co., Kenosha, Wis. 8½x11, 4 pages.

TAYLOR "DUBL-RESPONSE" CONTROL SYSTEMS, Taylor Instrument Co., Rochester, N. Y. 8½x11, 35 pages. Bulletin 37R.

TYPE GA DIESEL ENGINES, Cooper-Bessemer Corp., Mount Vernon, Ohio. 8½x11, 12 pages.

HORIZONTAL DUPLEX PISTON PUMPS, Type PC, Worthington Pump & Machinery Corp., Harrison, N. J. 8½x11, 4 pages.

BUCYRUS-ERIE LOADMASTER CT-50, Bucyrus-Erie Co., South Milwaukee, Wis. 8½x11, 6 pages.

THE STORY OF THE RESTORATION OF THE WASHINGTON MONUMENT, Medusa Portland Cement Co., Cleveland, Ohio. 8½x11, 12 pages.

GYPSTEEL PLANK, American Cyanamid & Chemical Corp., New York City. 8½x11, 24 pages.

MANUAL OF TIMBER CONNECTOR CONSTRUCTION, Timber Engineering Co., Washington, D. C. 8½x11, 26 pages.

DEEP WELL TURBINE PUMPS, Worthington Pump & Machinery Corp., Harrison, N. J. 8½x11, 8 pages.

BONNEY TOOLS, Bonney Forge & Tool Works, Allentown, Pa. 8½x11, 48 pages. Catalog No. 35.

ARMORED CONCRETE, Armored Concrete Corp., Newark, N. J. 8½x11, 23 pages. Catalog V.

EMULSIFIED ASPHALT, The Texas Co., New York City. 6x9, 16 pages.

THERM-O-TILE STEAM CONDUIT SYSTEMS, H. W. Porter & Co., Newark, N. J. 8½x11, 8 pages.

NEW EQUIPMENT FOR HEAVY CONSTRUCTION WORK, Ingersoll-Rand, New York City. 8½x11, 4 pages.

USE DUTCH BOY AND GET ALL 3, National Lead Co., New York City. 9x12, 8 pages. White Lead Paint.

SIDE SUCTION CENTRIFUGAL PUMPS, Lawrence Machine & Pump Corp., Lawrence, Mass. 8½x11, 4 pages. Bulletin 202.

MOTORS FOR CENTRIFUGALS, The Louis Allis Co., Milwaukee, Wis. 8½x11, 4 pages. Bulletin No. 601.

Business Notes

C. R. PAYNE of the Mellon Institute of Industrial Research, has resigned that position to become associated with the Atlas Mineral Products Co., Mertztown, Pa. Mr. Payne, who since 1928 has been a member of the research staff of the Mellon Institute, has developed several acid-resisting cements. In his new position he will devote his time to the supervision and the production of these compounds.

THE BRIGGS MFG. CO., Detroit, Mich., has appointed Lyman C. Athy as superintendent of the new plumbing division. Harry G. Franklin was made regional manager of the west-north-central territory and J. B. Stewart, regional manager of the east-north-central territory.

USL BATTERY CORP., announces the election of R. T. Pierson as vice president and general manager. Mr. Pierson, who has been head of the power battery division takes over the position of A. A. McLean who has resigned.